MACHINERY.

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THE SIEMENS & HALSKE WORKS, AT CHARLOTTENBURG, GERMANY.

ROBERT GRIMSHAW.

THE most important of the various machine shops, etc., of this immense concern is located in Charlottenburg, an important suburb of Berlin—and most appropriately for electrical works, on Franklin-strasse. The situation is convenient to water shipment by the Spree. The works present, not merely from the "Ufer," a river bank, but from the cross street (Franklin-strasse), an unimposing appearance, and give no impression of the extent, importance and variety of work done therein.

Premising with the remark that this establishment is called the Wernerwerke, after Werner von Siemens, one of the distinguished trio of brothers who have achieved success and fame in the distinct lines of (1) electricity, (2) steel making, and (3) glass making and economical heating and lighting with gas, I will invite the reader to enter with me the modest main portal, to the left of which are the directors' offices, and those for the assistant engineers, and the business department. Telephone lines connect these with all other departments. To the right is the managers' department and the office for paymasters and the like. A large new office building is going up; and in close connection with the main building come the stock rooms, the physical experimental laboratory, etc., and one catches a view of an immense new machine shop in construction. As is frequently the case, even in immense machine building establishments in Germany, there is no foundry; founding being usually, here, a distinct business from machine building.

Crossing the "court" we come to the main machine-shop, two views of which are shown in Figs. 1 and 5.

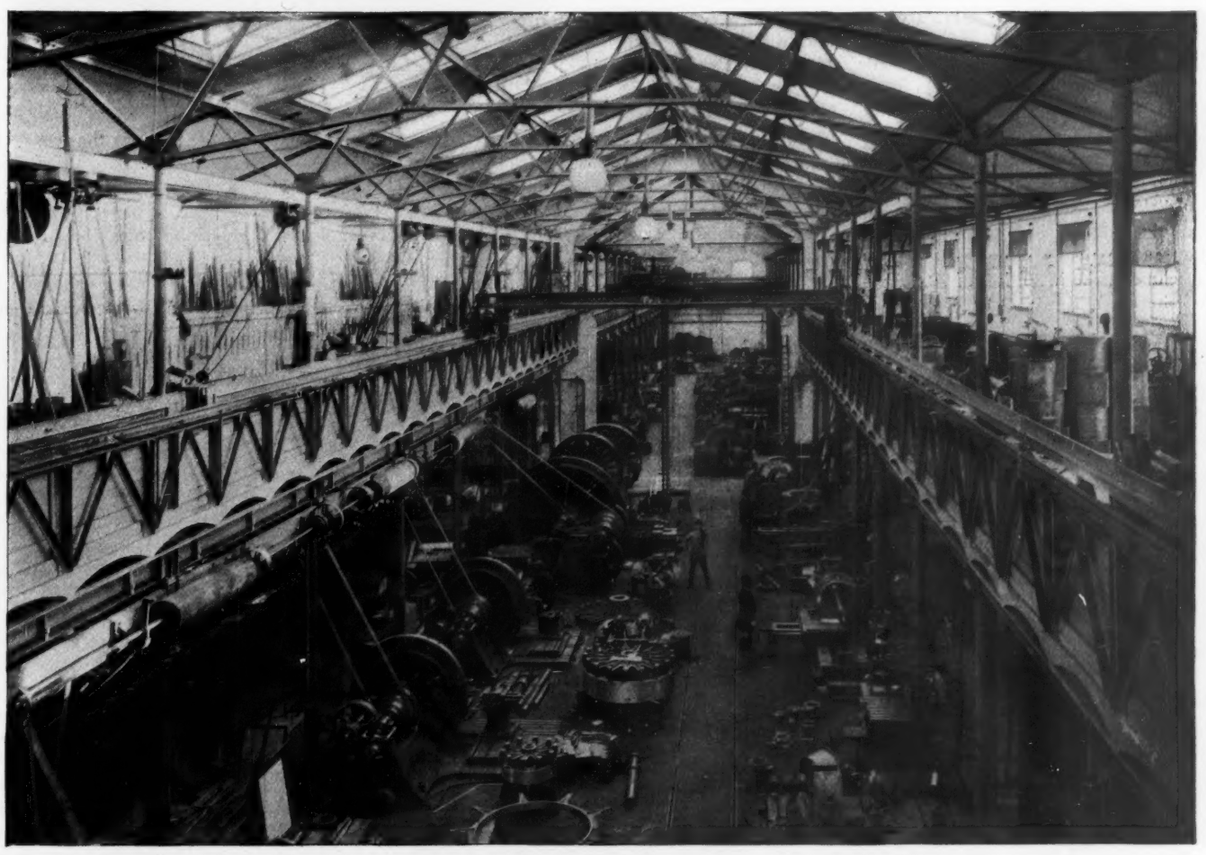


FIG. 1. VIEW IN MAIN SHOP.

One interesting machine is an emery grinder for arbors, etc., with an automatic device for stopping the operation when the required diameter is reached. This machine, shown in the illustration, Fig. 2, is made by Sponholz & Wrede, Berlin. The measuring apparatus consists of an angle-arm with vertical and horizontal members in the proportion of 50 to 1. The horizontal arm fits in a slot in a vertical measuring slide, which is moved up and down by means of a curve having such outline that the slide falls whenever the emery wheel goes once over the entire length of the cylindrical surface to be ground. When the desired diameter is attained, the upper end of the slot in the slide presses on the horizontal lever-arm, and pulls the upright member down; then the stop on the slide *S* is no longer held up by the stop on the up-right lever arm. The slide then falls clear down and presses on a lever arrangement, which draws the lever *H* to the right and throws out the friction coupling, thus stopping the machine.

The gradual forward feed of the carriage is effected by a fine screw having a star feed. Each time that the wheel carriage is at one end or other of its course, the wheel is advanced 1-100 millimeter = 0.0004 inch.

In the manufacture, thousandwise, of toothed sheet-iron armature disks, there are employed several classes of machines, of which some are of special construction and interest. In the first place, the iron sheets as they come from the mill are covered with white paper. The sheets are fed into a machine over which the white paper in long rolls is placed; the rolls are pasted on one side by the machine, then the iron sheets and the pasted paper pass

between wooden rolls which press them tightly together. The compound sheet is then taken to the punching presses, great and small, which cut out the disks, some having merely a central hole, others a number of other holes, for through-bolts, etc., according to the type. These finally have to be toothed on their periphery. Several of the machines for this purpose are hand-fed; that is, each disk is separately clamped, the machine is started, and its indexing device rotates the disk until all the teeth are cut (by a side punch), and then the disk must be replaced by hand. The rate of cutting is about 120 teeth per minute while at work.

The machine here shown (Fig. 4) for automatically cutting the teeth in sheet-iron disks or rings for electro motors, is built by the Berliner Werkzeugmaschinenfabrik. It has 30 mm. stroke, 10 mm. adjustment of punch, and cuts the teeth on disks from 100 to 1,000 mm. (say 4 to 40 inches) diameter. The bed is 60 inches long. On it is mounted an eccentric press and a carriage movable by screw and handwheel, and with clamping device for the disk. The spacing is automatic. It cuts the teeth internally as well as externally, in which respect it differs from other tooth-punching machines. For internal cutting, the ring is put on four pins which are adjustable at any desired distance from the center, on a cross-piece, and held by clamp screws. The matrix is held on a hook-formed piece attached to the main frame, and is adjustable by three screws. Suitable stops prevent the carriage being brought too far forwards in first setting a new disk after the machine is once arranged for disks of any given diameter.

For external punching there are a mandrel and two clamping disks by which the work is held. The upper disk has a slot so that it is not necessary to remove the clamping nut each time. The under disk bears also a thin disk which serves to center the work. For external punching the hook-formed matrix (or die) holder is not necessary. The machine stops on the completion of each disk, the punch remaining in the highest position.

Two of these machines have an ingenious attachment by which the disks are lifted one by one from a pile of several hundred, brought into position, held while being rotated and punched, and then automatically removed and dropped in a third pile. This attachment, the invention of Mr. Hundhausen, of the Siemens & Halske establishment, has three horizontal radial arms 120 degrees apart, revolving about a vertical axis, and each supplied with a central suction appliance which automatically drops on to the pile (the disks are paper side up), lifts one disk, turns 120 degrees to the punching apparatus, drops the disk and holds it by mechanical pressure while it is being rotated and toothed, then lifts it again by suction, carries it 120 degrees further, and there drops it on the pile of finished disks. Each of the piles is formed about a vertical "stake," so that the disks are properly presented to the sucker, and piled orderly when toothed.

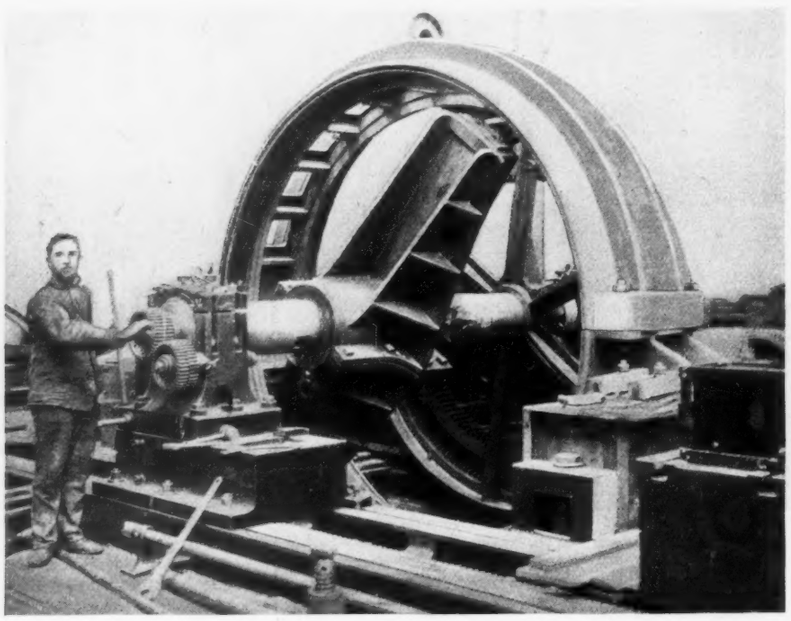


FIG. 3. A LARGE BORING MACHINE.

One very massive horizontal boring machine (Fig. 3), built by Collet & Engelhard, of Offenbach-on-the-Main, is not handsome, but strong, and of capacity up to 20 feet internal diameter. It is especially intended for dynamo frames. The bed is in two parts, one each side of the pit, and each having lengthwise slots on the inner and the upper surface. On the inner faces are two carriages which are movable by rack and pinion and carry between them a bridge-piece which is adjustable in hight by a spindle. There are two such bridge-pieces which can be moved forward and backward and upward and downward, and which serve to receive the feet or the flanges of the dynamo frames.

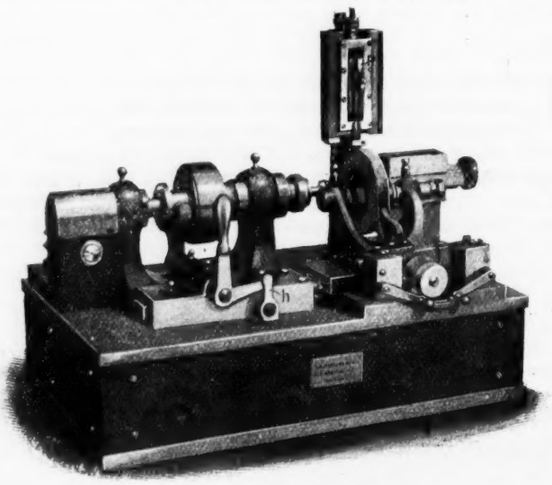


FIG. 2. EMERY GRINDER.

Both milling and boring tools are available, so that the feet can be milled off and the ring frame bored out. The boring spindle is drive direct by an electro motor on its carriage, which has automatic adjustment or feed on the cross-piece, at several suitable speeds; the motor effecting both the rotation of the spindle and the motion of the carriage.

The boring bar shown in the illustration is of steel, running in adjustable composition boxes, which rest on heavy supports, that are movable by racks and pinion on the side beds. This boring bar carries a double arm, the steel tools of which are radially adjustable either by hand or automatically; and this arm has automatic feed along the bar, at several speeds. The bar is rotated by a toothed ring carried by a stout cross-shaped piece on its end. This ring gears with any desired one of several pinions driven by an electro motor, which is carried by a bed separate from that of the tool, this bed being movable by rack and pinion.

Among other noteworthy machines are a milling machine working up to 48-inch radius, made by the Deutsche Werkzeugmaschinenfabrik in Chemnitz; a double-face rotary planer by Sondermann; a double boring machine from God's country, by Bullard; a radial drill by Zimmermann, of Chemnitz (with the gears boxed in), and a "double triple" boring machine or drill press, i. e., two drill presses, each with three spindles, back to back on one casting, and having automatic withdrawal, by L. Sentker, of Berlin.

The cranes are of various types mostly electrically driven and the three-motor type being evidently preferred. But there are also hand cranes where the application of the current would be inconvenient or would not pay.

In the cable department there are many interesting special machines. The spinning machines which form the inner conductors of copper wire differ but little from those in cordage works. The covering machines are, of course, special. In one type of cable an inner conducting core of seven copper wires is wrapped with stout paper by being passed through the axis of a rotating arm, the end of which bears the spool of paper ribbon. Then this is covered with tar, by passing through a trough in which the waterproofing liquid is kept thoroughly agitated. Next

comes a layer of flat galvanized iron wire strands, applied spirally; then a layer of hemp; and this is (simply to make it more

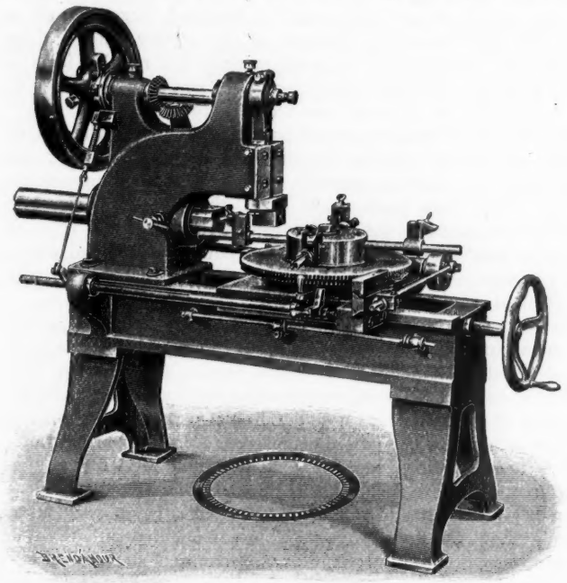


FIG 4. MACHINE FOR SLOTTING DISCS.

convenient to handle than if it were tarry) well coated with chalk. The chalking machine is simple. There are on a horizontal axis, about 3 inches apart, two sheet-iron wheels, each formed of two disks connected by curved buckets. The adjacent faces of these wheels have one perforation opening into each bucket compartment. The cable passes along between these bucket-wheels; their rotation scoops up a thick solution or emulsion of chalk, which pours out of the side orifices on to the cable.

All the aforementioned operations except the spinning of the internal seven-fold conductor are performed continuously and automatically in what practically constitutes one machine, and the product is coiled up on a huge reel. If it is required to be lead-coated, it goes to one of two great hydraulic machines (one works with cold and the other with melted lead), and under a pressure of 300 to 500 atmospheres gets a lead pipe made around it and pressed most intimately into all the recesses and roughnesses of its outer surface. Sometimes a lead-covered cable is again coated with paper, tarred, hemp-covered, wire-protected, chalked, and again protected by wire.

The area of the buildings at present occupied is 269,000 square feet, and there are 4,000 employes. In the shops, 1,366 machine tools are driven from countershafts and 444 others by electro motors. There are 472 electro motors in all. These figures give an idea of the extent of the works, and of the extent, also, to which electric power is being introduced.

TRANSMISSION OF POWER ON NAVAL VESSELS.

THE ADVANTAGES AND DISADVANTAGES OF STEAM, HYDRAULIC, PNEUMATIC AND ELECTRICAL TRANSMISSION.

The paper read by Geo. W. Dickie, of San Francisco, before the last meeting of the Mechanical Engineers, upon the subject of power transmission on naval vessels was full of interest and we abstract a few brief notes from it.

At the outset Mr. Dickie assumed that all operations on a warship requiring power: first, can be performed by steam direct from the boilers; second, can be performed by water under a high pressure imparted to it by steam operated pumps; third, can be performed by air under pressure imparted to it by steam-operated air-compressors; fourth, can be performed by electric motors, using a current generated in a central station by steam-driven generators. He further stated that mixed systems have been used because it has been supposed that each of the four systems was suited to some functions and not to others; and he took as the main purpose of his paper the discussion as to how far his assumption holds true that each system can be used alone for all the operations on a warship.

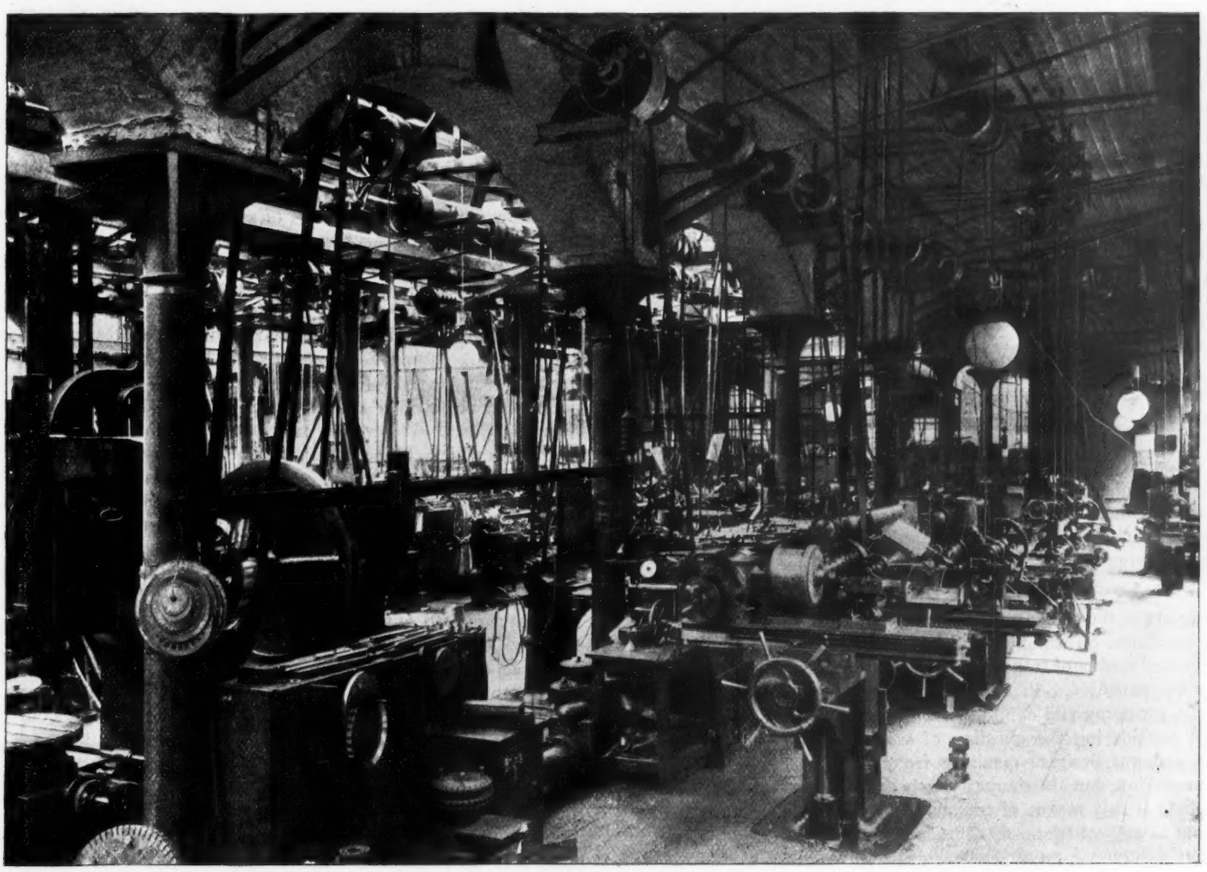


FIG. 5 VIEW IN MAIN SHOP.

THE USE OF STEAM.

In all of our war vessels steam is used direct on a large number

of the auxiliary machines throughout the vessel, and in all of them, except those fitted with hydraulic steering gear, the steam is carried from end to end of the ship, the steam windlass being at the one end and the steam steering gear at the other, requiring two lines of steam-heated pipe for the whole length of the vessel. Between these points, both on upper and lower decks, machines are operated by steam on all our ships. On the upper decks there are steam winches, steam windlass, steam boat cranes, and steam ash hoists; and on lower decks, outside the engine and boiler compartments, there are steam ventilating fans, steam air-compressors for torpedo-charging, steam steering gear, and in some of the vessels, steam turning gear for turrets, and steam ammunition hoists.

Granted that steam can be used to operate every kind of auxiliary machine on a warship, and seeing that it is on hand at all times and always ready, how comes it that on all of our ships this steam is converted into some other form of energy and in this new form is applied to certain operations that it might just as well be applied to direct?

Those who claim that steam should be converted into some other form of energy and distributed to the various machines base their claim on three points of advantage—safety, economy and comfort. It would be difficult to over-estimate the loss which might result from a broken steam pipe in any compartment under the main deck of a war vessel in action. Such an accident might not only involve the loss of all men in such a compartment, but the total disablement of the ship as a fighting machine.

It is difficult to determine the relative economy of steam as applied direct throughout a ship, and as applied through some other agent. The great source of loss is through condensation. Nearly all the machines which use steam in naval vessels, outside of those directly connected with the propelling of the vessel, do so intermittently, and masses of metal must be heated up every time a movement is made. Beside this source of waste, the steam engines used for auxiliary work are of necessity of the most wasteful character. As a rule they are reversing, the reversing gear usually consisting of a reversing valve operated through some form of floating lever. The waste of steam in this class of engines is enormous, and we hardly think that on an average a horse-power is obtained for each one hundred pounds of steam used. The combined waste from condensation and wasteful motors must result in a large expenditure of fuel in proportion to the work done, and in our opinion makes the direct application of steam to auxiliary machinery on warships the least economical of the methods in use.

The objection to the direct use of steam on account of the discomfort caused by heat in places difficult to ventilate efficiently is, perhaps, the most serious objection made to this method of power distribution. Steam and exhaust pipes running to the various machines must be carried as a matter of safety below the protective deck line, and for the same reason all engines requiring to be operated in time of action are also placed below that deck, where ventilation is very difficult, even where there are no engines. It is difficult to see how men can possibly carry on the work of tending such engines, serve ammunition hoists, and perform all the duties required of the under-deck force in time of battle.

HYDRAULIC TRANSMISSION.

We are of the opinion that most of the work required of auxiliary machines on warships can be better done by hydraulic than any other means of transmission; and if so, how about the qualities we considered in connection with steam applied direct—safety, economy and comfort?

In considering the question of safety we must not only take into account dangers resulting from accident to the means of transmission, but the danger which might result to the vessel as a whole if this means of transmission was not as reliable in its action as any other means of transmitting power.

The danger we pointed out from the possibility of damage to a steam pipe where steam was used direct, does not exist in connection with hydraulic transmission; the result being simply cutting out of service the machine to which such a pipe leads. As to reliability, our experience proves that after the first difficulties are overcome there is no form of power transmission which can be depended upon with more confidence than hydraulic.

Granting, then, that this system is eminently safe, is it an economical method of distribution?

It has generally been allowed even by those who are most strongly in favor of its adoption that, owing to the conditions which govern the operation of most auxiliaries on board warships, economy must be sacrificed when a hydraulic system is adopted. Hydraulic motors for any of the varied purposes requiring power on warships must be designed large enough to meet the maximum requirements of the service, and if these motors are of the piston or plunger type, the regular form at present in use, the maximum amount of power will always be used, although the minimum work only is required.

If, instead of using a motor having cylinders with moving pistons or rams, utilizing the pressure to obtain power, and measuring out a given quantity of water for each movement, irrespective of the work to be done, the pressure water was applied to a properly designed wheel of the tangential type, an efficiency averaging about 70 per cent. could be obtained with a great variation in the load, and thus one source of waste with this system would be avoided.

The American mania for direct-acting steam pumps to generate power for such an installation is the most fatal obstacle to be encountered in any effort to reach reasonable economy in a hydraulic system of power transmission on board our warships. In some of the battleships now building it is proposed to install, for the generation of hydraulic power, say six duplex hydraulic pumps of 400 gallons capacity each per minute, at 600 pounds pressure per square inch; this requires twelve steam cylinders, 22 inches diameter, and say 24 inches stroke, being with pump friction about 950 horse-power. This will require with the type of pump proposed not less than 95,000 pounds of steam per hour, and this certainly would give on the main engines 5,000 horse-power. Half the total boiler power of the ship with forced draught would be absorbed by such a pump installation, if working at its full capacity.

As to comfort: The presence of hydraulic pipes in any of the living spaces, store rooms, or magazines in no way affects the temperature or ventilation of such spaces. Any leakage is easily discovered and can do no damage. All joints, when once tight are likely to remain so, and motors work without noise.

COMPRESSED AIR.

Granting the possibility of a compressed-air system of power on warships being made serviceable for all auxiliary purposes, we may now consider the qualities of safety, economy, and comfort in their relation to this system.

Perhaps no form of power transmission has all the elements of safety in the same degree as compressed air. A leak in the transmission pipes improves the ventilation and adds to the comfort of those working in that compartment. The pressure carried, of say six atmospheres, makes all kinds of connections simple and easily cared for. Double bottoms and difficult places of access can be purified and ventilated by a small jet from the distributing pipes. Water may be excluded from any damaged compartment which can be made air-tight down to the level of the opening that admits the water. Any compartment in a warship using a compressed-air system of power transmission can be promptly cleared of water by this means, the extent of the aperture by which the water enters being of no consequence.

In the matter of economy, both in generating and in distribution, the compressed air, if proper methods are adopted, should be at least equal to any of the other systems which have been tried. The compressors used should be of the most modern type—triple expansion of steam and triple compression of air, and with storage enough to meet sudden calls. With the most economical steam engine, operating the most economical compressor, and the compressed air converted into useful work through economical air motors, this system of power transmission on warships should meet every requirement on the score of economy.

As to comfort, we have already pointed out some of its advantages. No return pipes are required, as in all other systems, electricity not excepted. The liberated air from motors will ventilate and cool the spaces in which they operate, and these spaces are usually the most difficult to ventilate.

In the hydraulic system all losses by leakage must be made up by fresh water manufactured on board, whereas by this system the more loss the better it feels where the loss has occurred, and the feeling of absolute safety in case of any break in the transmission pipes must add to the efficiency of the men whose duty requires them to work beside the motors and the pipes which supply the power to them.

ELECTRICAL TRANSMISSION.

The advocates of this system have a foundation for their method of power transmission which those who favor any of the other methods do not possess, in the fact that all modern warships have a certain amount of power converted into electric energy and distributed throughout the ship for lighting purposes.

In regard to safety: We might safely take it for granted that whatever disturbance would fracture the pipes of an air or water system would part the wires of an electric system. In that case the danger to life and also to the ship would be far greater with the electric system than with the others. Automatic safeties could be applied to almost any conceivable extent against such accidents, yet, where safety devices are needed, the system cannot be so safe as where no safety devices are needed.

As to economy: The electric generating plant has been developed both electrically and commercially into a high degree of efficiency. Direct-operated generators are now driven by engines of the very highest developed type. These engines are so perfectly controlled by automatic valve governors that full load or no load may be the condition without apparent change in the working of the steam motor.

The generators may be so divided into units as to meet the conditions of work at any time without much of the steam engine power running without load. Lighting and power can be taken from the same installation, thus effecting a saving in the labor of attendance. There is no doubt that the economy of generating the power electrically will be better than with either water or air, owing to the high speed of the engines and the small amount of loss in the generating mechanism.

In regard to the distribution, the losses, by careful installation, can be reduced until they shall at least not exceed the losses of friction in either air or water pipes of the other methods. Careful designing may also reduce the losses in converting the electric energy into mechanical movements, so that the economy of this part of the system may be better than in either air or water motors.

In regard to comfort, it cannot be claimed that an electric system of power transmission on a warship, like a compressed-air system, can be made the means of increasing the comfort of living on board. On this point it should rank with a hydraulic system. The facility with which electric energy can be converted into rapid rotary motion makes ventilation wherever that power is distributed a very simple matter, and electric fans, both fixed and portable, especially where little or no heat is generated, would supply pure air to all parts needing artificial ventilation.

Mr. Dickie further stated that when steam, compressed air or electricity is used for handling heavy masses, like guns or turrets, it is necessary to employ an automatic hydraulic controlling apparatus in order to secure reliability and delicacy in the movements.

VAN NORMAN "DUPLEX" MILLING MACHINE.

No class of machines is making more headway in modern shop practice than the milling machine in its various forms. Several main types have appeared with the spindles working in fixed planes or positions, the horizontal spindle machine, in either its plain or universal form, being in most general use for index milling, slab or gang milling, and for tool-room requirements.

In recent years the superior utility of the vertical spindle milling machine for surface milling by means of face or end mills has been demonstrated, and to-day this class of machine is rapidly supplanting the planer or shaper for many kinds of work.

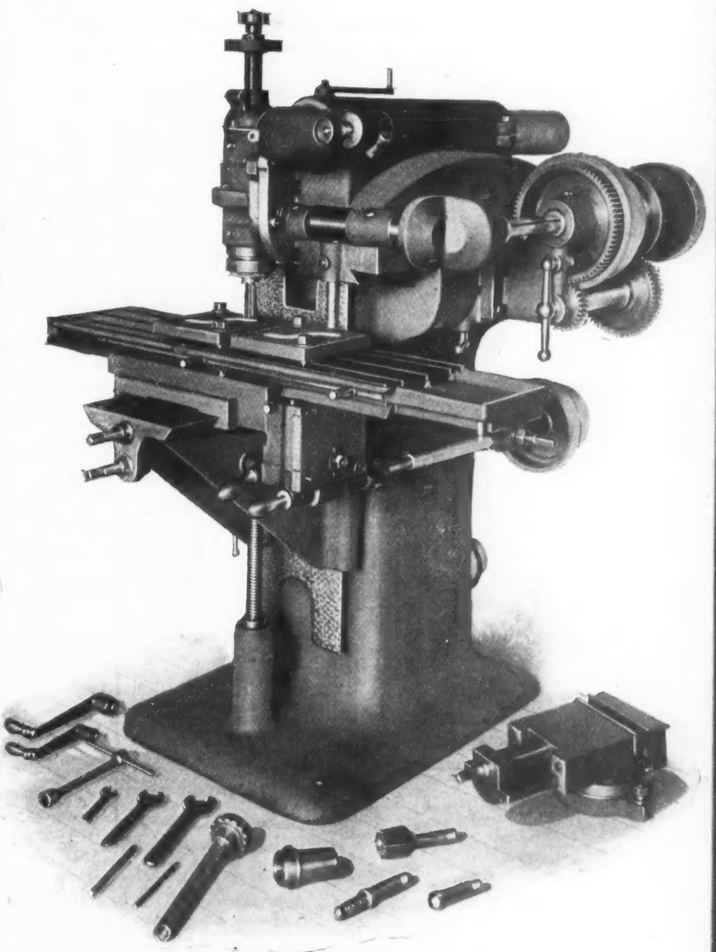
The Van Norman "Duplex" milling machine, made by the Waltham Watch Tool Co., Springfield, Mass., embodies valuable features of both the horizontal and vertical types, and its movable cutter head permits cutting operations at any angle from vertical to horizontal.

The column, knee, and working slides of this machine are of the ordinary form. The cutter head, however, is pivotally mounted on the wall of a rigidly constructed movable frame, which can be moved in and out over the column to bring the cutter into the best cutting relation when set at its various positions or angles.

When the cutter is used in its horizontal position, the frame is ordinarily carried back on the column, while for vertical or angular milling it can be moved out to the requisite distance and means are provided for securely clamping in any position. An overhanging arm is mounted in the frame for use in slab milling, etc., when the spindle is placed in its horizontal position, as on the ordinary horizontal machine.

The driving pulley with back gear mechanism is mounted on a bracket attached to the side of the column, and through this pulley passes a splined driving shaft having bevel gear connection with the main cutter spindle.

For profiling, a stud is inserted in the outer lower face of the movable frame, and a form bolted to the table is kept in contact with the stud by means of the slide screws, thus guiding the work in relation to the cutter as in the regular profiling machines. In the illustration the machine is shown as arranged for this work, with the form and the cam plate to be cut in place on the table. While most of the operations of this character are done with the spindle in its vertical position, the device will be found effective for special cuts with the cutting spindle placed at an angle.



VAN NORMAN MILLING MACHINE.

It will readily be seen that work may be clamped to the table and operated on in many positions without releasing the clamps, and that such an arrangement will often avoid special fixtures. A saving of cutters is also effected, as angle cuts may be made with the simplest form of right angle or end mill cutters.

In addition to the above features, provision is made for drilling at any angle by having an interior sliding spindle at the center of the main spindle. This spindle is removable and is inserted from the back end of the main spindle. It is held in place by the large cap nut shown in the illustration. This auxiliary spindle will feed in line with the spindle when set at any angle, and can be used for drilling or counterboring.

The cut represents the No. 2 machine, with the following general dimensions: Length of automatic feed of table in either direction, 28 inches; feed in and out from column, 10 inches; vertical feed, 18 inches; movement of main frame over column, 12 inches. Spindle has No. 13 B. & S. taper hole. Interior sliding spindle, which can be attached or removed in a moment, has No. 7 B. & S. taper hole. Length of feed of interior spindle, 3 inches; weight of machine, 2,500 lbs.

AN ATTACHMENT FOR PLANING LINKS.

We have received from Mr. Joseph Ryhner, Watsonville, California, sketches of a circular planing attachment for planing links. He writes that with an attachment which he made he planed the circular parts of two pairs of bar links (marine style), four bars, and two slide blocks in about a day and a half.

Two views of the device are shown in the sketches in Fig. 2. An old style swivel chuck is bolted to the planer table and a slotted rocker arm is bolted to the top part of the chuck. The long bell crank lever, which is shown, works on a stud screwed into the planer table. The long arm of the lever is attached to a

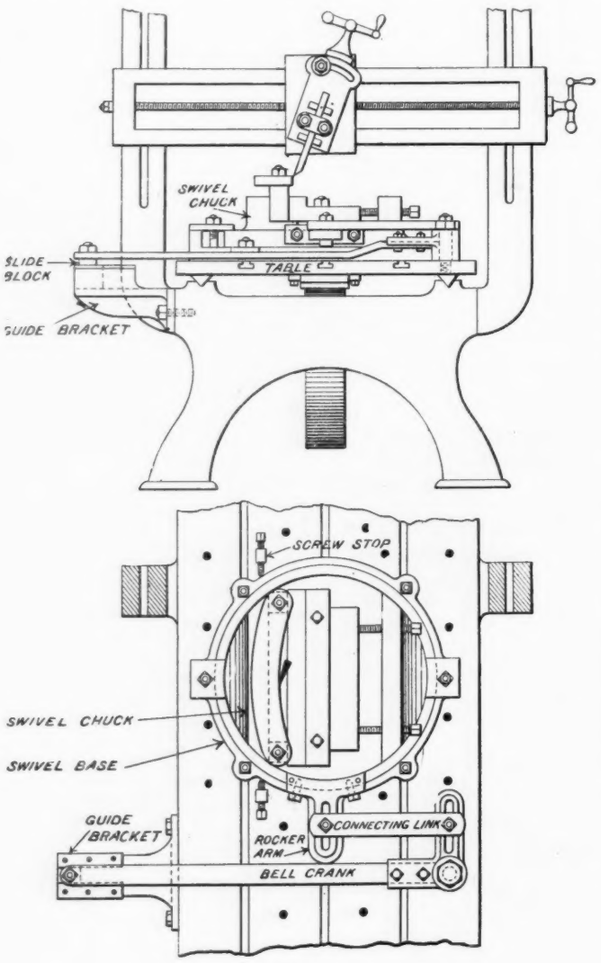


FIG. 1.

slide block, which is free to slide back and forth between the guides on the guide bracket, the latter being bolted to the planer bed. The short arm of the bell crank is slotted and is connected with the rocker arm on the chuck by a connecting link. As the planer table moves back and forth, the bell crank lever moves with it and gives the chuck the necessary oscillating, rotary motion, the amount of this motion being regulated by varying the position of the connecting link.

In Fig. 2 is shown a detail of the pins used to connect the connecting link with the rocker arm and the short arm of the bell

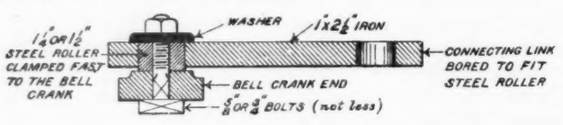

1/4 OR 1/2" STEEL ROLLER CLAMPED FAST TO THE BELL CRANK
WASHER
1"x2 1/2" IRON
CONNECTING LINK BORED TO FIT STEEL ROLLER
BELL CRANK END
5/8 OR 3/4" BOLTS (not less)

FIG. 2.

crank. The construction is plainly indicated, and while the pins clamp tight to the two arms, the connecting has a free movement about the pins.

The following directions for using the attachment were sent by Mr. Rhyner: "First mark off the correct curve on the link and then put it in the center of the chuck endwise. (The other way does not matter.) Set the planer with the right stroke for the length of the link, put in a side tool, set over the head,* and run the table back and forth to see how the movement corresponds with the line on the link."

"To get the correct movement or radius, all that is necessary is to move the connecting link, keeping it parallel with the long arm of the bell crank. After one side is finished, change the head and tool to the other side, but do not move the connecting link. Should it happen that one end of the link comes a little narrower than the other end, do not change the link, but screw the chuck up or down, as the case may be, by means of the screw stops shown. It is needless for me to say that all joints must be a good fit."

MECHANICAL DRAFT—No. 6.

WALTER B. SNOW.

The action of the chimney is most nearly approached in its operation by the induced system of mechanical draft, under which a partial vacuum is produced within the furnace. As compared with the chimney, it is under ordinary conditions capable of producing far greater intensity of draft. Acting in the same manner as the chimney, it is under ready control, not, however, by a mere closing of dampers, but by actual change in the speed of the fan and consequently of the degree of vacuum produced. Its leakage is always inward, and as a consequence all inconvenience from flame and smoke is avoided, which cannot be said to be the case with undergrate forced draft, where the pressure is high and proper damper arrangements are not provided. On shipboard excellent ventilation is produced in the open fire rooms, which is possible when induced mechanical draft is used and their temperature is correspondingly reduced. It is naturally cleanly in operation and subject to ready control. In all classes of work, except possibly on shipboard, in which the construction may prevent, it is well adapted, for it is usually possible to place the fans above the boilers so as to avoid occupying valuable floor space.

In the early days of the application of this system it was stated that fans operated under the imposed conditions would be unable to withstand the heat by the gases passing through them. The best refutation of this claim lies in the fact that fans have been operated for years under this system without showing serious deterioration, although handling gases at from 300 to 500 degrees. It is obvious that to withstand this temperature the fans must be of somewhat special construction, particularly as regards their shaft bearings, which are generally provided with special water cooling devices.

Manifestly, it is impossible to make any broad and unqualified statement as to the relative economic advantages of forced and induced draft, for the conditions seriously affect the results. Conditions that may be favorable to forced draft may be just the opposite as regards the induced system. In Table No. 22 are presented the results of comparative tests between these two systems, conducted upon marine boilers at the Portsmouth (England) dock yard in 1890. Both tests were made upon the same boiler, the induced draft being dismantled and the forced draft substituted. To the decreased tendency of the former system to

TABLE NO. 22.—RESULTS OF EXPERIMENTS WITH INDUCED AND FORCED DRAFT AT PORTSMOUTH (ENGLAND) DOCK YARD.

Kind of Draft.	Duration, Hours.	Average Steam Pressure, pounds.	Temperature. Feed.	Temperature. Atmosphere.	Total Coal Consumed, pounds.	Total Water Evaporated, pounds.	Pounds of Water Evaporated per pound of Coal. At actual Temperature.	Pounds of Water Evaporated per pound of Coal. At 212°.	Pounds of Coal Cosumed per hour per long foot of Grate.	Pounds of Water Evaporated per hour per sq. ft. of Grate. Actual Temperature.	Pounds of Water Evaporated per hour per sq. ft. of Grate. At 212°.	Approximate I. H. P.
Induced..	96	74.2	62°	69.9°	80 600	777 044	9.64	11.13	40.4	389.6	450.4	426
Forced...	96	77.3	51	49.8	94 500	750 328	8.03	9.3	47.3	381.	444.	395

superiority of induced draft. The claim is also made for this system that the partial vacuum produced in the tubes causes the flow of gases to be uniform across the section of the tube, thereby insuring better contact and readier abstraction of heat than is blow holes through the fire, and the better regulation and distribution of the air, may undoubtedly be attributed a part of the

* The handle of the down feed should not, of course, be drawn in an inclined position—the mistake of our draftsman in "setting over" the tool. (Ed.)

the case with forced draft, under which the gases entering the tube ends form a contracted vein.

While these results show the evident superiority of induced draft under the given conditions it would be hardly fair to give them much broader application.

One of the important features of induced draft lies in the ready opportunity which is presented for the introduction of different types of air or water heaters, by which heat may be abstracted from the gases and the true economic value of mechanical draft thereby secured. For the efficient operation of such a device considerable draft (more than is furnished by the ordinary chimney) is an absolute necessity.

The reduction in the temperature of the gases which is brought about by such an arrangement not only increases efficiency of the plant, but also has an appreciable effect upon the proportions of the fan; for the cooler the gases, the less their bulk and the lower the peripheral speed of the fan required to produce the necessary draft pressure. In a fan operating under the pressure or forced system, the volume of air supplied to the fire is substantially the same as that delivered by the fan, if no allowance is made for leakage. But when induced draft is employed, it is necessary that the fan should handle a quantity of air and gases, which, although the same in weight, is greater in volume in practically the ratio of the absolute temperature. Disregarding leakage, the weight is greater than the air admitted by the portion of the coal which has entered into chemical combination with it. On a basis of 18 pounds of air per pound of coal, this additional weight amounts to 5.5 per cent., while with a supply of 26 pounds it is 4.2 per cent. It is hardly necessary under ordinary conditions to give heed to this increased weight, because of the inherent elasticity of this system, due to the variation possible in fan speed. As a rule, sufficient accuracy is secured by considering that air is the fluid handled, and that the theoretic relations between the volume, weight and pressure, and the speed and power of fan already indicated, holds fairly well in practice.

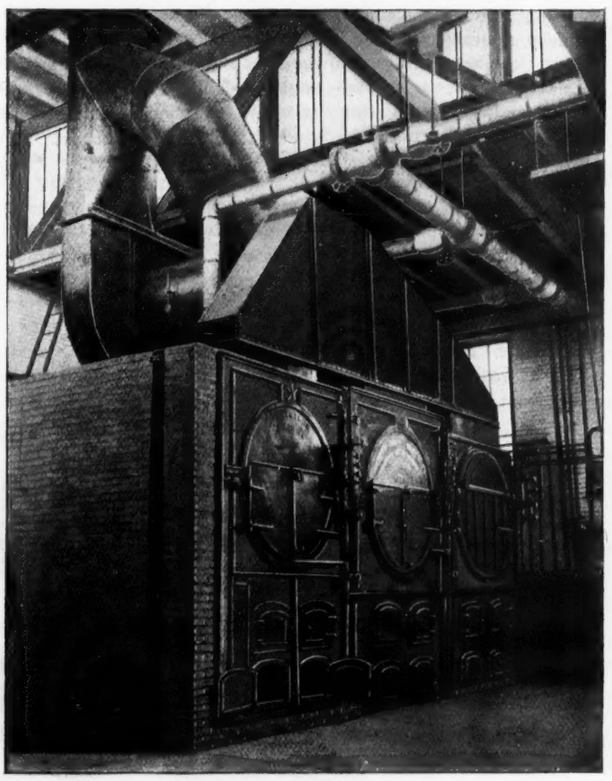


FIG. 5. THE PLANT OF THE B. F. STURTEVANT CO.

An interesting example of the application of induced draft to a comparatively small boiler plant is that illustrated in Fig. 5. In this plant, of the works of the B. F. Sturtevant Company, Jamaica Plains, Mass., are three horizontal return tubular boilers, two of which are 66 inches in diameter, each containing 123 tubes 3 inches in diameter by 15 feet long, and the third 60 inches in diameter, with 64 tubes 3½ inches in diameter by 15 feet long. The aggregate horse-power, on builders' rating, is 260 horse-power. Upon the boilers is placed a special 90-inch Sturtevant exhauster, to which is attached a 5 x 4 double upright engine. The speed of the engine, and in consequence the intensity of the draft, is regulated by a special device which serves to open the throttle and increase the steam supply in proportion as the steam pressure is reduced.

The introduction of this fan was necessitated by the removal of the boilers to a point over 100 feet from their previous location, and that of the chimney which had previously been employed to produce the draft. This distance was manifestly too great to permit of further use of the chimney, and its removal was out of the question. It was therefore allowed to stand as a useless monument to a discarded method of draft production. A new chimney in the desired location would have cost about $1,450, and would have occupied valuable floor-room. The fan with its short stack would cost only $700; hence its adoption when its other advantages were considered. The fan, as installed, was provided with a by-pass, which, up to date, has never been used.

Three comparative tests were run upon this plant, upon successive days, as follows:

Test No. 1—Run on middle boiler; dampers to other two boilers closed and packed; fire drawn, and all steam and water connections broken. Fan engine under control of special regulator.

Test No. 2—Conditions same as in No. 1, except that fan engine was fitted with Waters governor, and damper in inlet connection to fan was operated by Locke damper regulator.

Test No. 3—Run on three boilers. Fan engine regulated as in No. 1. Fire even, not drawn, but running, start and stop were made.

The air supply was determined by anemometer readings at the ashpit doors.

The coal used in tests Nos. 1 and 2 was clear George's Creek, Cumberland, costing $3.65 per ton of 2,000 pounds. In test No. 3 this was mixed half and half with yard screenings, costing $2 per ton, making the cost of the mixture $2.82½ per ton.

The principal results of these tests are presented in Table No. 23. In tests Nos. 1 and 2 the boiler was intentionally forced above its rated capacity, in the first instance by 93 per cent, and in the second by 49 per cent.

TABLE NO. 23.—RESULTS OF TESTS BY INDUCED DRAFT, PLANT AT THE WORKS OF THE B. F. STURTEVANT CO. JAMAICA PLAIN, MASS.

	Test No. 1.	Test No. 2.	Test No. 3.
Duration, hours	11.5	11.52	11.55
Average steam gauge pressure, pounds	79.4	79.3	78.9
Average temperature of feed water, degrees	175.3	189.5	148.6
Grate surface, square feet	30.25	30.25	85.5
Coal burned, including coal equivalent of wood, pounds	7461.7	5723.3	13613.5
Total combustible consumed, pounds	7005.8	5263.3	12691.1
Air per pound of coal burned, pounds	20.12	20.80	21.81
Water evaporated into dry steam from and at 212° per pound of coal, pounds	10.10	10.15	9.28
Water evaporated into dry steam from and at 212° per pound of combustible, pounds	10.75	11.04	9.95
Coal burned per square foot of grate, pounds	21.45	16.45	5.09
Average draft pressure in ash-pit, inches of water.	0.144	0.078	0.057
" " " at back, " " "	0.640	0.372	0.581
" " " at fan, " " "	1.253	1.743	1.342
Steam used by fan engine per pound of water evaporated (dry steam 212°), pounds	0.0416	0.0769	0.036

The consumption of coal per square foot of grate reached 21.45 pounds per hour in the case of the first test, and although no special arrangement of the grates was made the air supply was only 20.12 pounds per pound of coal. Undoubtedly a far less amount would have sufficed had this been the subject of special care. The evaporation per pound of combustible from and at 212 degrees was only 2½ per cent. greater in the second test where the combustion rate was considerably lower.

As will be noted, the amount of steam required to operate the fan engine varied considerably in the three cases, being relatively least in the two tests in which the engine was automatically regulated. The second test, in which the fan speed was maintained at a constant maximum by means of a Waters governor, presented practically the same conditions as would hold with a plant operated by chimney. The draft was in this test adapted to the requirements by the manipulation of a damper. The higher expenditure of steam for draft production is to be noted. The fan

engine being designed primarily for continuous running and great durability was not as economical of steam as might have been the case. Had the steam consumption been only 30 pounds per horse-power per hour the fan would have required in the third test only 1.7 per cent. of total output of the boilers. In larger plants the expenditure is well within one per cent., and even the greater part of the heat in this steam would be saved by feed-water heaters in any well regulated steam plant.

As already stated, one of the great advantages and conveniences of induced mechanical draft is the feasibility of introducing therewith efficient heat abstractors. The s.s. Kensington, of the Red Star Line International Navigation Co., presents an excel-

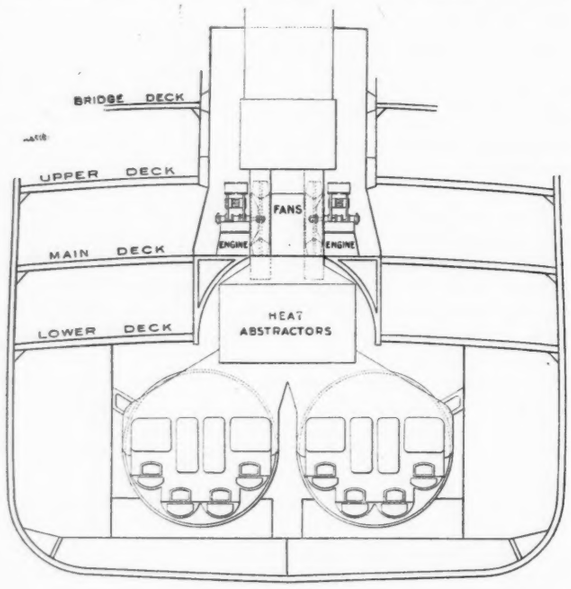


FIG. 6.

lent illustration of such an application on shipboard. This vessel, of 8,670 tons, has two sets of quadruple expansion engines. The steam is generated in three Scotch boilers, two of which are double ended and one single ended, carrying 200 pounds.

The total grate area is 383 square feet, and total heating surface 12,176 square feet. The boilers are fitted with Serve tubes 3¼ inches diameter, with 1⅜ inches space between. The Ellis & Eaves system of induced draft is fitted, and the boilers in one compartment and exhaust into one chimney stack. The fans, of which there are five, are situated at the base of the funnel and driven by direct-connected engines. The general arrangement of boilers, heat abstractors and fans is shown in outline in Fig. 6. The fans are applied on the induced principle, and draw the gases across tubes through which the air passes on its way to the boiler furnaces. A considerable part of the waste heat is thus extracted and used, while the volume and temperature of the gases are sufficiently reduced to more readily facilitate their being handled by the fans.

TABLE NO. 24.—RESULTS FROM LOG OF ROUND TRIP VOYAGE OF S. S. KENSINGTON.

Items.	Voyage No. 30.	Voyage No. 31.
Direction bound	East	West
Date of departure	June 30, 1897	July 24, 1897
Date of arrival	July 11, 1897	Aug. 3, 1897
Time of passage, dock to dock, days, hours, minutes.	10:13:29	10:14:30
Time of passage, sea, days, hours, minutes	10: 6:16	9:15:31
Average steam pressure, pounds	195	1935
Average fan suction, inches of water	3.5	3.0
Average vacuum in air reservoirs, inches of water.	0.625	0.5
Average vacuum in ash-pits, inches of water	1.75	0.625
Average indicated horse power, inches of water	7841	6870
Knots per hour	13 74	14.03
Coal per I. H. P., pounds	1.43	1.59
Coal per hour per square foot of grate, pounds	20.3	28.66
I. H. P. per square foot of grate	20.47	17.93
I. H. P. per square foot of heating surface	0.643	0.564
Temperature of gases of fan discharge, degs. F.	427	383
" in air reservoirs, degs. F.	329	296
" of atmosphere, degs. F	62	58
" of fire-room, degs. F.	83	87

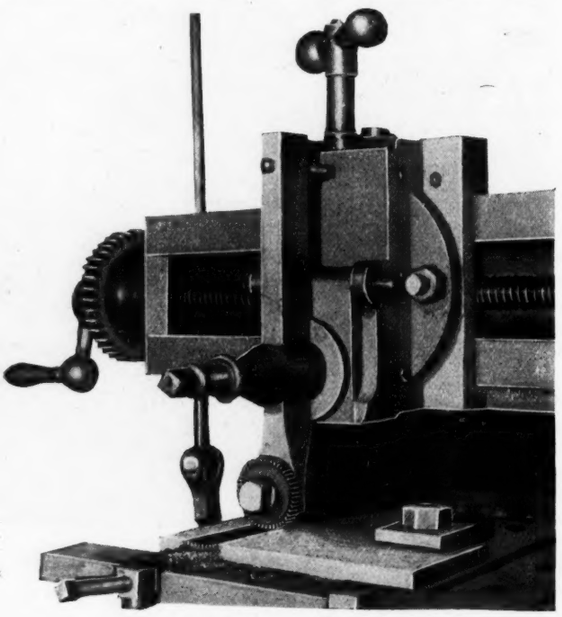
The results from a log or round trip voyage are given in Table No. 24. In the calculation of the coal consumed per indicated horse-power, there has been included the amount used at sea for the auxiliaries and all other purposes on board the ship. The indication of power from steam made by the boilers is indicated by that passing through the main engines only.

A TOOL FOR PLANING RACKS.

The illustration shown herewith is made from a photograph of a tool for planing racks, which works on the principle of forming the teeth as the work progresses, similar to the cutter used in the Fellows gear shaper, as described in the last issue. This tool is intended to be placed in the tool post of a planer, and the rack is planed by feeding the cutter along, just as an ordinary planer tool is fed, without regard to the pitch of the rack.

The cutter consists of a pinion of tool steel, the front side of which is dished out so as to give a good cutting edge to the front of the teeth. The pinion is mounted on a bar of suitable size to fit the tool post, and is free to revolve on the shoulder screw which fastens it to the bar. When starting a cut, the tool is fed downward to the required depth of the tooth, and then the cross feed of the planer is started, and as the saddle advances the cutter revolves, and will plane a rack of any desired length by shifting along the blank, if necessary. When the planer table returns, the tool of course must relieve itself, but as the spacing takes place on the return, if the tool should rise too far out of the rack tooth, the spacing would evidently be inaccurate. To guard against this, an adjusting screw is placed at the top of the cutter bar, which can be set to allow just enough motion for the tool to clear, but not enough to spoil the accuracy of the teeth.

To further guard against inaccuracy, there is a spring pin bearing against the top of the cutter, which always keeps the lower or cutting part of the cutter in solid contact with the bar.



PLANING A RACK.

The illustration is made from a pinion 2 inches in diameter and of 24 pitch. A cutter of this size has forty-eight teeth, and consequently several are cutting at once. If the planer is not strong enough to carry this cut, therefore, without chattering, it would be advisable to use a cutter of smaller diameter. Where the pitch is very coarse, it would probably be best to use as small a pinion as possible.

The first of these tools was made by Louis T. Weiss, 286 Graham street, Brooklyn, about two years ago, and has been used by him successfully. He now manufactures them, and apparently they make an inexpensive and convenient way of cutting racks. It is well known that it is difficult to arrange gearing to space racks correctly when cut on the planer, for the reason that the cross-feed screw is always made some even pitch per inch, while a diametral pitch rack is always some fractional pitch per inch, which it is difficult to obtain without complicated gearing. This point the cutter illustrated takes care of very nicely, since the accuracy of the rack must depend entirely upon the accuracy of the cutter, providing the latter does not have too great a movement when clearing itself on the return stroke.

TEST BARS AND THEIR RELATION TO THE STRENGTH OF CASTINGS.

Herbert E. Field.

Periodically such discussion of test bars as Messrs. Keep, West and Dr. Molendyke are now indulging in, are brought to the attention of readers of industrial and scientific journals.

It has always appeared to me that this controversy over the merits and demerits of the ½-inch square bar and the 1-inch square or round bar, has been an instance of the one stopping his ears while the other talks, and vice versa. I think that a careful study of the situation will reveal that, while both may be correct to a certain extent in the limited sphere to which they confine their experiments and arguments, yet, when we consider the test bar in the broader sense as a universal standard for determining the strength of iron in castings, the methods advocated by them fall far short of the excellence claimed.

TEST BARS.

It is not my intention to discuss, at any length, the relative value of the inch or ½-inch bar; but I wish to show, if possible, where both fail to accomplish the purpose for which they are, or at least should be, used. However, before commencing this, the most important part of this article, let me write a few words to those who insist upon using this method of testing their iron.

Of the large number who break the transverse bar from each cast, I should like to know how many carefully calliper the bar; how many note the difference in size between the ends of the bar adjoining and opposite the gate, and how many realize what a proportionately great difference in the strength of the bar a very slight difference in the height or in the diameter makes. I think I may safely say that not one in ten takes the above precautions. No molder, however careful, can cast two bars from the same pattern exactly alike. Whether the bars be cast on end or flat, there is bound to be a difference in the size of the bar at the opposite ends, unless an allowance for this variation is made in the construction of the pattern.

Whenever a new pattern is needed, it is probably measured carefully by the foreman or whoever makes the test, and perhaps for the first day or two the bars may be measured, but after that they are broken either as ½-inch or 1-inch bars and recorded as such, while in reality there may be a difference in size sufficient to cause the tester to wonder what can have happened to his mixture. So the poor melter or the much abused pig iron agent may have to stand the blame which is solely due to the fact that his bar is a thirty-second small and that he hasn't noticed the deficiency. If you find that you are using the same mixture two days and get different results, measure your test bars at the point of rupture and see if they agree.

The fact that the bars are somewhat larger at one end than the other, makes the accurate measuring of a rough bar difficult. For although you may get the approximate size at the center of the bar where the knife edge is to bear, in many cases the bar does not break at that point. A measurement taken at the break afterwards is of no value except for comparison, since the bar generally decreases in size under strain. Another point which is quite noticeable is the fact that there is a difference in strength between the two ends of the bar, depending upon how the bar is cast. This can be best proven by turning small tensile specimens out of opposite ends, or where this is not possible, by cutting the bar in the center and by decreasing the distances between the supports in your testing machine and by breaking each half separately.

A few foundries, noticing the above faults, cast their test bars an eighth to a quarter of an inch large and have them machined in the center (only) down to the required size. This is a very good plan, and not only does away with the liability of the bars varying in size, but insures their breaking in the center, and thus makes all the tests uniform.

The above faults to be found in the transverse test, together with the recognized fact that all rectangular bars develop marked weakness lines in cooling, leads up to the second fact that I wish to bring out—that is, the great advantage of the tensile over the transverse test. The tensile strength of cast iron is very much in excess of its transverse strength. Hence, even if the rough bar is tested, the proportionate variation in strength, due to a small difference in diameter, is much smaller in the case of the tensile test. In nearly every series of experiments carried on in this line, it has been shown that as the transverse strength increases, the hardness increases. This is certainly true up to a point where cast iron is much too hard for ordinary uses. Tensile tests, on the other hand, serve as a very accurate guide to the quality of iron. The old theory that high tensile strength irons are always hard irons has long been disproved. Hence, if one can improve the tensile strength of his iron, he is almost sure to be improving its physical qualities. The strongest iron which I have ever tested gave a tensile strength of 44,000 pounds per square inch, and was one of the best irons to machine. It is for this reason that I urge upon foundrymen the advisability of the use of the tensile test when it is possible. The first cost may be somewhat greater, but the results are enough superior to warrant the outlay.

TEST BARS: VS. CASTINGS.

The tendency of to-day is to aim first to get iron test bars strong, regardless of the other qualities of iron which go to make up the perfect casting. When competition is as strong as it is to-day, the saving in machine work on the casting has often much to do with the ability to do work cheaply. Therefore, in mixing iron for machine work this should be kept constantly in mind. The number of castings which require a high strength is comparatively small, so that softness of iron should in many cases be considered rather than a boasted strength, which in the specific instance may be of no real value to the casting.

The fact that a ½-inch or inch square bar has been cast out of the same ladle as a certain casting, and that the bar shows a high transverse test, is generally taken to mean that the casting, regardless of its size and shape, has the same strength. It may have, but the probability is that it has not. The iron has been cast into molds of entirely different shape and thickness. The quality of the sand and the moisture it contains are sure to vary. Thus the test and the casting will cool under entirely different conditions. If the casting be very much thicker than the test bar, as is often the case, the test bar will set cool, and perhaps be dumped out of the flask before the graphite has ceased to separate in the iron of the casting. On the other hand, if the casting be stove plate or other thin work, the opposite may be true.

Will there be any similarity between irons cast under such different conditions? Let us suppose that we are running a stove plate foundry and on a certain day the transverse strength of the ½-inch square test bar, in the course of treatment by Mr. Keep's mechanical analysis, falls a few hundred pounds below the standard that we have fixed for our work. Something must be done. So we judge either from the above named analysis, or for some other reason, that our iron is running a little too soft. We proceed to harden it for the next heat. On the following day we find that we have regained our old standard, and congratulate ourselves accordingly. But for what? For the fact that we have added 200 pounds strength to a ½-inch square bar, while ten chances to one we have weakened every casting made that day. If you do not believe this statement, try for yourself. Take one of your ½-inch test bars and have it turned to a tensile test. Then take a piece of your thin casting and treat it likewise. If your machine will not break it, send it where it can be broken. If you are convinced of this fact, it may save you dollars that you are now expending in useless tests.

Let us make one more supposition. Suppose you are using the 1-inch test bar and find that, for some unexplained reason, it falls in strength. You are making a heavier grade of casting from 1½ to 2 or 3 inches in thickness.

You find, perhaps, that your scrap is running a little harder than usual, and so by use, say, of a higher silicon iron you bring your 1-inch test back to its required strength. But how about the casting? Instead of softening, it, being of large dimensions, probably needed the opposite treatment, and yet, in order to bring an unused test bar up to a certain strength, you have weakened the more important pieces. The question is, Are you working to improve your castings, or are you working to gain some standard strength in a test piece which may or may not represent in any degree the strength of any casting in the heat? The question here arises, Is there no way to determine the true strength of the iron in our casting? There are two methods.

The first, and it is preferable when possible, is to take a test out

of some representative casting which has been rejected on account of a defect. Most foundries have such castings occasionally. In this way, and in this way only, can the testing be said to represent truly the strength of the iron in the casting. One test a week made in this way is worth more than the thirty or forty transverse bars that many foundries break in an equal time. You know what your iron is in your casting. They know what it is in their test bars, which is a very different thing.

The second method is to cast a test in the casting of such shape and in such a position as will best give the true strength of the casting. This is the only method that can be used when the strength of a specific casting is desired. The test bar, while not exactly the casting itself, is cast under precisely the same conditions, and gives a fairly accurate test of the casting. The test piece should, if possible, be made to correspond to that part of the casting which, on account of its size or position, is most liable to break. In this way, by ascertaining the strength of the weakest part, we have the true strength of the casting.

It will soon be recognized, I feel certain, that the present tendency to work for test bars, and thus neglect the strength of castings, is an erroneous one. The plea of Dr. Molendyke for a universal uniform test bar appears to be not only an impossibility, but also an absurd proposition. The one fact that it is possible to pour from one ladle of good iron a series of tests which shall vary from 15,000 to 27,000 pounds tensile strength, should show this. Many will probably at first doubt this statement, but they can prove it for themselves by simply making the pieces cast of sufficient variation in size.

A simpler way, perhaps, is to take three or four parts of different thickness out of some rejected casting. Let these pieces vary as much as possible in thickness.

If a set of standard test bars were agreed upon in order to represent to any degree of correctness the strength of cast iron, the number of those standards must be legion. There would have to be as great a number of bars as there are thicknesses of casting, and they would have to be cast under as many and as varying conditions.

Many of the readers of this paper have often wondered, as I have, at the extraordinary high tests obtained by the so-called semi-steel people. You may believe what you wish, and they may assert what they please, but, to my mind, only the smallest of the castings—say, those not exceeding 1 inch in thickness—would ever reach anywhere near the strength that their lists record.

Every test which I have seen recorded by them has been turned from a bar of 1 inch or less in diameter. A brief personal experience will show how I was led to believe this, and it perhaps may be of value to others. A short time ago one of the offices of the corporation by which I am employed pointed out to me four tests recorded in the report of "Tests of Metals," issued by the Ordnance Department of the United States Government These tests were sent to Watertown Arsenal, and were broken in the government Emery testing machine.

In a joking way he asked me why I didn't reach the 42,000 to 49,000-pound tests recorded there. I called his attention to the fact that they were taken from small bars, two being but 1 inch square, while two were only ½ inch square. I then went out into our yard, and picking up an ordinary drop gate of about 1¼ diameter, had it turned up and tested. It gave a tensile strength of 40,000 pounds per square inch, while the test which represented the true strength of the casting had given but 30,000. Another incident which happened last week is only another of the many which go to confirm the fact, that you can get almost any strength out of iron if you only have it cast in the correct form and size.

I picked a piece of water pipe out of the scrap heap and had it turned up till it was about a sixteenth of an inch thick, and when broken it gave a calculated strength of 27,000 pounds per square inch, or only 700 pounds below the government requirement for gun iron. This was made from a mixture of machinery scrap and a No. 2 Southern coke iron. These go still further to show how little relation there is between the strength of test bars and the strength of the iron in the castings.

Of course, in special contract work, where certain specifications are furnished as to strength, etc., it is necessary to work to those tests which are specified. It is, however, frequently the case that inspectors reject castings where the test plugs fail, when a test taken from a casting would have stood the test, and many, I fear, are accepted where the test plug is up to the strength, when the iron in the casting would not stand an equal test.

If there is an object in view, it is well enough to work to your test; but when a founder is working simply to improve his own product, he should by all means endeavor to improve his castings, and not the strength of a ½-inch or 1-inch test bar.

The discussion as to whether a ½-inch bar or a 1-inch bar test "indicates degrees in the strength of the iron to agree with the chemical analysis," appears to me to be a mere waste of time and words. Every iron having a certain chemical analysis has, theoretically, a certain sized test piece that will give it a maximum strength. Without a doubt, the ½-inch test bar better coincides with the chemical tests of stove plate than would a 1-inch bar. A test taken from the different thicknesses of plate would, however, coincide much better.

I hope that in the few notes that are written above, I may have led some at least to think a little more deeply upon this subject of stronger castings versus stronger test bars.

EARLY POWER PRESSES.

WORK OF A VERMONT MAN IN THIS LINE WITH SOME INFORMATION FROM MR. N. C. STILES.

We have received from Mr. J. R. Rand, Brattleboro, Vermont, photographs and descriptions of some punching and trimming presses which were among the first of their kind to be built. Mr. Rand writes as follows:

"I expect the press in Fig. 1 is one of the antiquities. It was made in Townshend, Mass., about 1855, by Mr. Smith, who was getting up tools to make organ reeds. It was bought, about 1858, with other tools, by Mr. J. D. Whitney, who for many years was in the organ reed business at Brattleboro, during which time he designed and built several ingenious machines for the manufacture of reeds.

"The press rests on a wooden bench with driving gear underneath. The tight and loose pulleys are on the shaft with the flywheel, which is geared down to about 6 to 1 to the crank shaft. In connection with the wrought iron lever and crank for connection to the toggle, it gives a very powerful drive. The lever, which is seen projecting at the rear, is simply a bell-crank lever pivoted on the pin or shaft, which is seen at the side of the frame.

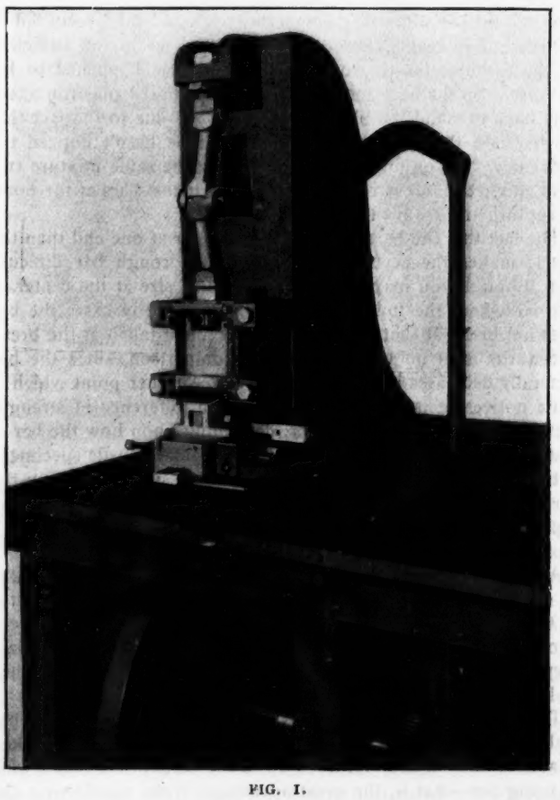


FIG. 1.

The distance of the punch in the die is regulated by nuts each side of the projection at the top of the frame. There was another press of the same pattern, made about five years before this one by Mr. Rice, of Worcester, Mass., who did the work on the other press also.

AN EARLY INCLINED PRESS.

"Fig. 2 shows the first inclined press designed and made by Mr. Whitney in 1868 or 1869. It can be set at two different angles, at which it is used for different operations, but cannot be tipped to an upright position. The lower end of frame fits inside the upper

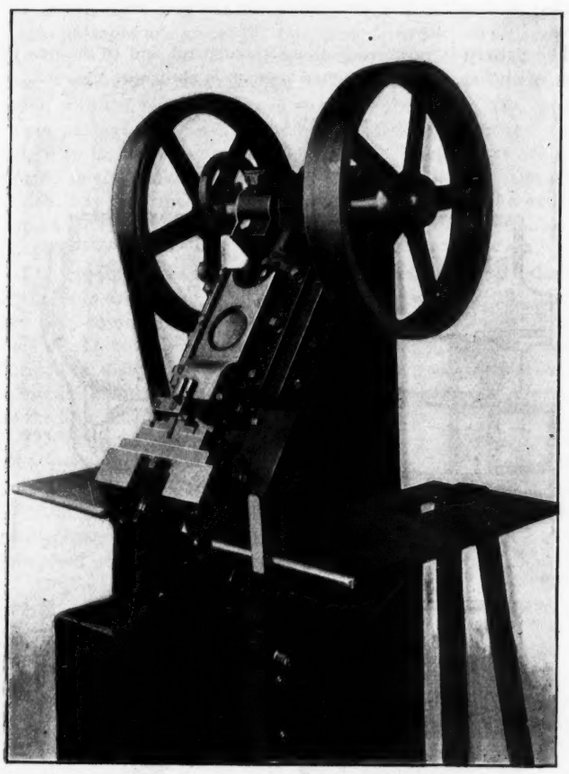


FIG. 2.

end of the base and is hung on studs about the middle of the width. At the back are holes in the frame and base through which to pass bolts to secure it at the different angles.

"The incentive for the inclined press was the quick getting away of the work after the operation. The machines are run quite fast on brass work and are fed automatically. The cam that operates the feed is seen near the left-hand wheel, but the feed itself was not on at the time the photograph was taken.

"The counter shaft is under the floor. The left-hand wheel takes a belt in the most upright position, the right-hand one in the other position. This is merely for convenience, as different lengths of belt are required for the two positions.

"Mr. Whitney made another press about 1880 which can be set from straight up to an angle of about 45 degrees. It is hung at the front, the back braces swinging into slots in the top of the base, which otherwise is a solid plate. It has webbed wheels which prevent the strips which are being punched from getting in the revolving mechanism, as they sometimes do when there are spokes or arms.

"These machines are exceedingly well proportioned and well built. They are now in use by the Estey Organ Company, at Brattleboro, to whose superintendent, Mr. J. Gray Estey, I am indebted for permission to obtain the photographs.

"I think Mr. Whitney was also the first to make and use sectional dies and punches in this country or any other country."

DATA FROM MR. N. C. STILES.

After receiving the above communication from Mr. Rand, we wrote to Mr. N. C. Stiles regarding the history of power presses in this country, believing that he would be acquainted with any early presses that might have been made. He sent us a copy of an old Stiles & Parker catalogue, in which was a cut of an early adjustable press, designed and patented by Mr. Stiles, and which is shown in Fig. 3. The date of the patent is August 27, 1872.

With regard to the adjustable presses he says: "Presses set on the incline, not adjustable but rigid, were in use some years previous to my first patent, but I believe myself to be the original inventor of the adjustable press."

It will be seen that Mr. Whitney's press was made some three years previous to Mr. Stiles', but it was adjustable in only two positions, while Mr. Stiles' could be set in any position.

Mr. Stiles further states that power presses were made earlier than 1855, the date of the Smith press, for the old Fowler press was made in 1853, and he is confident that that was not the first one. It is probable, therefore, that the first Smith press mentioned above, which was made about 1850, was one of the very early ones.

PRACTICAL PATTERN MAKING 9.

PATTERN WORK FOR HIGH-PRESSURE CYLINDER FOR MARINE ENGINE.

I. McKim Chase.

Illustration XVI. represents a more intricate casting made in a dry-sand mold. It shows the high-pressure cylinder of a compound engine having a valve chest and a receiver combined with the cylinder. 107 is a half plan and half cross section, and 108 is a vertical section, through the axes of the cylinder and valve chest.

Prior to commencing the construction of such a pattern, its position and the method of molding must be decided. Having chosen a horizontal position, the pattern will be made to part or separate through the axes of the cylinder and valve chest on the line *a*, *b*.

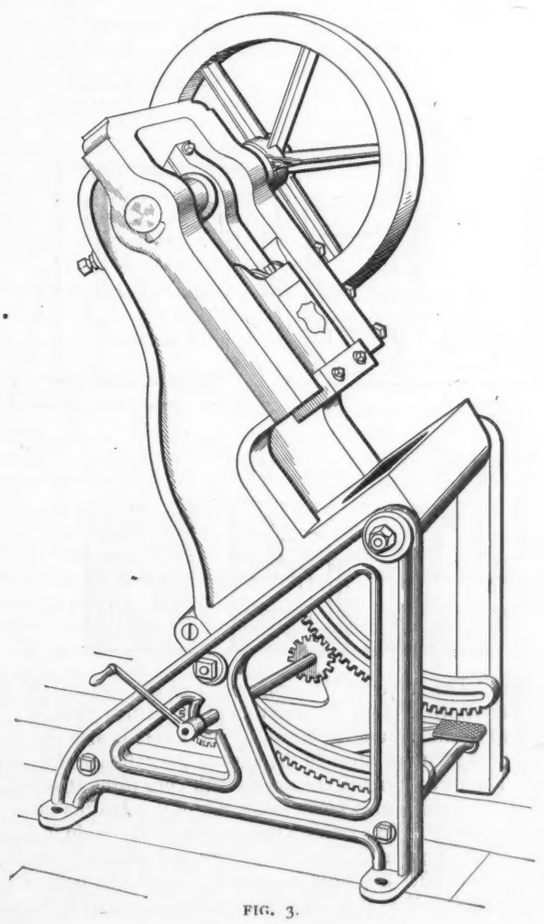


FIG. 3.

Four frames of 2-inch lumber are prepared. These frames extend beyond the cylinder proper, or casting, and the core print for the receiver core is formed on this extension. Each frame is made in two pieces, the joint running through the axes of the cylinder and valve chest. The contour of each frame is less by

about 1½ inches than the exterior of the finished pattern. The finished exterior is illustrated at 109.

A frame is placed at each end of the pattern, the other two being set intermediate and equidistant between the end ones, as shown at 110. The frames are covered on their outer edges with staves running parallel with the axis of the cylinder, as shown at 111. The staves are made of 2-inch lumber, and are secured to the frames with screws and glue. After dressing the ends of the staves fair with the frames, the pattern is lined off, and finished to this line by removing the surplus material with planes. The screws having been countersunk, to avoid coming in contact with the tools, the screw holes are filled by plugs.

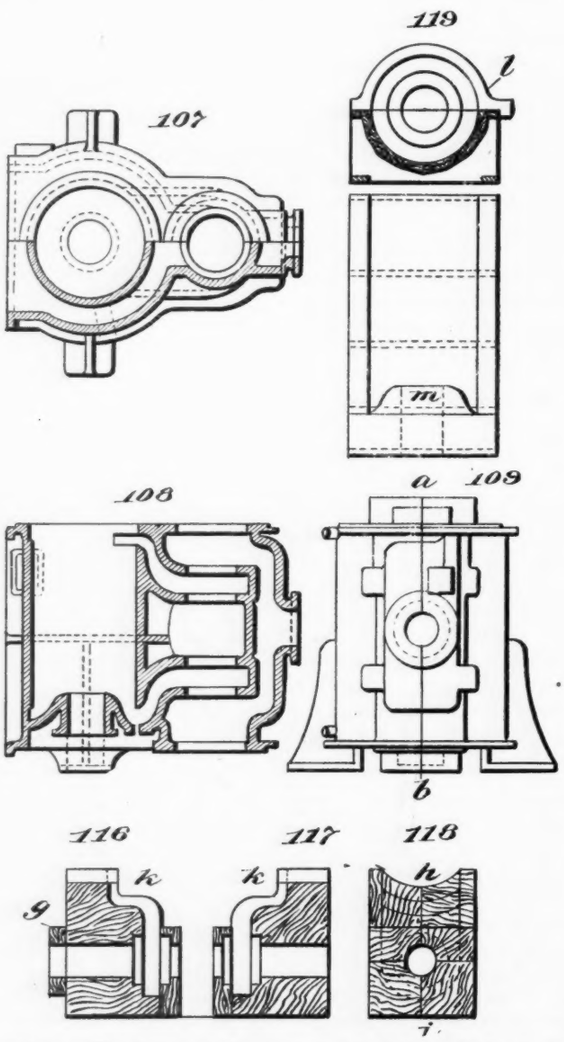
The lower head of the cylinder is cast in; that is, it is made a part of the casting. To form this head in the mold a piece is built up of segments, and turned to the required shape and dimensions. The frame at the proper end of the cylinder is cut away sufficiently to allow the insertion of the turned piece, which is secured to the pattern, as shown in 110, where is also shown a section of the pattern through the axes of the cylinder and valve chest. The piece forming the nozzle with core print attached is fitted to the head, and is made to lift out of it when the mold is being dissembled. This relieves that portion of the mold forming the head, which parts as does the pattern and allows of removal from the flask after the mold is opened. When this part of the mold, or drawback, as it is sometimes called, is removed, the pattern is free for withdrawal from the mold.

The part of the pattern that forms the valve chest is made in halves, with a core print at each end. It is built up of staves, in a similar manner to that of the body of the cylinder, and being of moderate size, is turned to the proper shape and dimensions in a lathe. The valve chest is secured to the other part of the pattern with screws and glue. The projections on the valve chest that form the outer walls of the steam passages are next fitted, after which the part containing the induction passage and nozzle is fitted and secured to the valve chest. This piece is made to part like the other portion of the pattern, and is worked out of solid material, the core print and flange being turned and added to it.

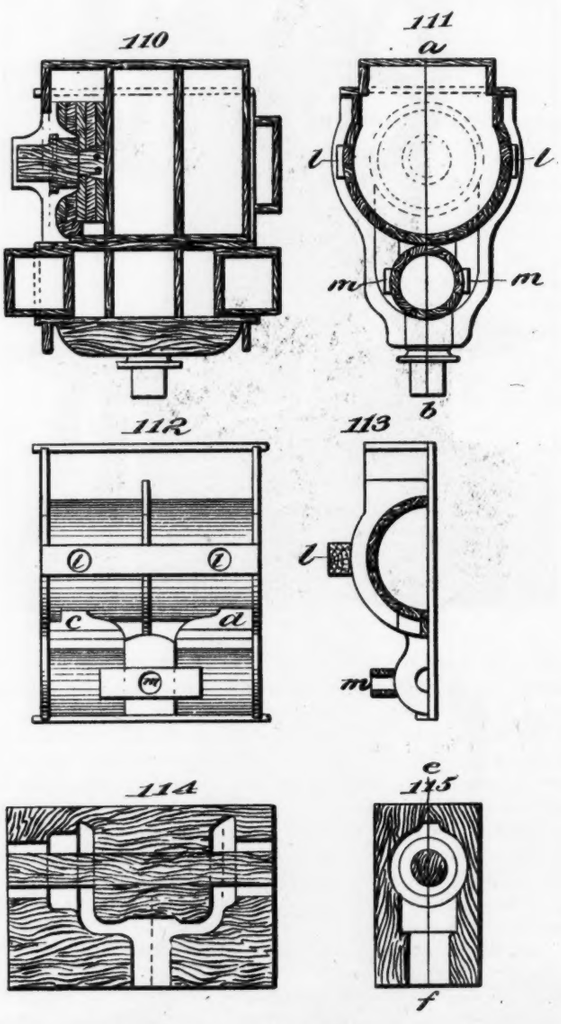
The top and bottom flanges, which extend all around the ends of the cylinder and valve chest, are next added, after which the brackets by which the casting is secured to the engine framing are added; also the bosses for the relief valves and facings for the hand holes, etc., are fitted. The core print for the upper or open end of the cylinder is built up of segments and turned to dimensions. It is secured to the end of the cylinder with screws and glue.

The pattern is now ready to be cleaned off and to receive its coat of shellac. The completed pattern is shown at 109.

XVI



XVI



The core box for the receiver core is illustrated in 112, where a plan and a sectional view, 113, are shown. It is a half box, the one box answering for both halves by having right and left pieces, *c*, *d*, which are secured in the box according to the half of core to be made.

The box is constructed by first preparing a bottom board, then fitting together the sides and mounting them on the board. The half cylinder which forms the inner wall of the receiver is constructed by preparing heads and securing staves to them, which, when worked off, will produce the required cylindrical dimensions. The upper edges of the sides are worked to the outer shape of the core, a straight-edge being used to sweep off the core to the form of the sides of the box.

Each half core is supported in the mold at the open end of the receiver, at two places on the cylinder, *l*, *l*, and at one on the valve chest *m*, where the cylindrical openings cut through the outer wall of the casting. The corresponding letters on the core box

show where the core is extended for this purpose. The openings are plugged up in course of finishing the casting.

Fig. 114 illustrates the core box for the induction passage to the valve chest. The view shows the inside of one-half the box when separated. Fig. 115 shows a section through both halves of the box. This core is made in halves, the parting being on the line *e*, *f*, and it is supported in the mold at the three ends where core prints have left impressions. A cylindrical opening is made through the core for the purpose of providing support for the cores for the steam passages to the cylinder.

Fig. 116 represents one-half the box in which the cores for the steam passages are made; the box is made to part or separate on the line *h*, *i*. Two of these cores are necessary, differing in length where they pass through the induction core. One core is made with the piece *g* attached to the box, and one, 117, for the upper passage without it. The box is made open on the upper side *k* to facilitate ramming the core up. These cores are supported in the mold on one side by the induction passage core, which they pass through, and on the other side by the exhaust end of the receiver core. It is necessary to support them also by chaplets.

Fig. 119 illustrates the core box for the interior of the cylinder. Two views are shown, a plan and an end view. For that part of the core containing its large diameter a half box for the lower half of the core is sufficient, the upper half of the core being formed by a strike, 1, which is shown in the position in which it is used. It is advisable to make both halves for the other end of the box, which contains the smaller diameter.

The part projecting inwardly, marked *m*, is made to lift out with the core when it is taken from the box, and is withdrawn from the core afterwards. This core can also be made by turning it up on a core barrel; but if this has to be specially made for it, to dispense with the core barrel and make a box like that above described will be found more economical.

PATTERN STORAGE.

Cisnarf.

The writer does not expect to create much discussion by asserting that the pattern shop is the worst managed part of an engineering manufactory. From the earliest machinery period, this department has been held up as the greatest "unnecessary evil" connected with machine building; the drawing room ranks next, and it is also the great drawback to that blessed happiness and content growing out of a full pocket-book, and unlimited business future. There exists something worse than this, however, a place where more or less system exists (generally less)—the pattern store-house. Visits have been made to many large works, where electric cranes, artificial ventilation, telephones, patent wash-basins, etc., were installed in all their glory and usefulness. They created an impression of careful management and thorough consideration of minute details; but, lo! in a dirty, ramshackle shanty, needy of paint and repairs, and stowed away in an obscure, unhandy corner of the plant, patterns are kept! In this place are patterns whose financial value is inestimable, and the loss of which would often necessitate the rebuilding of a business.

The drawing room is supposed to have records of these patterns; but how many do? Maybe one in a hundred. Then again, very often, little changes of vital importance are made during the construction of a pattern, which never reach the drawing room, partly from oversight, and partly because the pattern-shop doesn't want the drawing room to think it knows it all. But to get back to the store-house; it is only right to expect that this building should be amply protected against fire, not only within itself, but from adjoining buildings. In many cases, however, its position is hazardous, often in a place where the highest winds blow straight to it from the foundry; leaky roofs are as dangerous from fire as from rain. Like the building itself, so is its interior; for the patterns themselves are arranged in one grand mess, incapable of being deciphered, save by the human index, whose business it is "to remember where he puts them;" this mental phenomenon, generally a man of considerable standing (in years) with the concern, and, thanks to Fate, generally in robust health and not subject to days off, other than for sick "cousins"—his duty is to remember. He does it; but then he has other characteristics—ever ready to increase the amount of ignorance possessed by others, regarding the whereabouts of various pieces, and not too dumb to feel his own importance and to show the apparent mental strain of his position.

It is a risk to have conditions thus. In the first place, it is expensive. Take the case, for instance, of hunting up an old pattern. The "man" is searched for, and if not found readily, several others join in the search, with the result that after an expense, maybe, of a dollar or more, the wanted piece is produced. How many times this is repeated during the year, would probably appal the management, could they but know it, and its cost.

It is an easy matter to change this method, and it looks as if memory must play the most important part in this department. A few experiences in numbering and lettering might be stated, however, which are the results of observation and trial. There was one case where each piece was numbered and listed, until the lists rivalled a city directory; lead numbers, bought by the gross, were nailed or shellaced to the patterns, which were good as far as recording is concerned, but they didn't make it any easier to find the patterns. On each drawing every piece was given a number (and an initial letter), with the greatest care; but it was not long before two pieces numbered alike made their appearance, which only added to the confusion; and by and by, after a particularly hard knock, a pattern would shed one of its numbers, and 179 would change to 79 (the "ones" seemed to come off first). These "cast in" numbers were supposed to facilitate the ordering of new parts, but customers invariably sent for the "big gear on our last machine," or "the frame for our medium-sized press." It was necessary to consult the books to see what "our last machine" was, then, after a long delay, write the party, "Please send us broken piece to insure its exact duplication."

Numbers painted on patterns are often worse than nothing, as they scratch off in the sand and easily change from 8's to 6's, or 7's to 1's. On large pieces it was found satisfactory to make a set of rapping plates, with numbers cast on. This was considerable trouble, maybe, and often brought the numbers in ridiculous places; but in such cases a plate, with number only, was screwed on in a convenient position, and was found to last as long as the pattern. These large pieces were stored according to their consecutive letters and numbers; a tracing was made as an index, and once a month a blueprint, "up to date," was placed on a board in the storage room, where anyone could find what was wanted. At the side of this index was a number corresponding to a box or compartment on the floor above, which contained the smaller parts of the machine. The "man" was given charge of this, and it was his duty to see that pieces were returned to their proper places. No one else was allowed to put pieces back, but was ordered to lay them on the floor in front of or near the right position, if merely sought for for inspection; and if returned from the foundry, to place them in a heap, for "his" final distribution. These small parts were "paint" numbered, but all given the number of the frame, or whatever the largest piece was, and in spite of my previous criticism of paint, it was demonstrated that it took but little care to keep these numbers "on," for in sorting they had to be examined, and any number found wearing off was quickly repainted. Some little inconvenience was found in listing, as there were several buildings for holding patterns, but this was overcome by giving each building a limit in capacity, and numbering between these limits.

All gears were given the same number as the machine to which they belonged (no matter how many were for one machine) and stored together, standing on their rims; not a very good way, but the best that could be done. Sometimes, after a few months, they would become so "oval" from standing as to require truing up before being used. Like every other thing that's new, there was a little trouble at first, to get things in shape, and more than once it was decided to return to the old plan; but it was suggested that a new man be placed in charge, one who had no idea of the previous system, and it was surprising to see how quickly he "caught on" and got things running smoothly. The buildings are still the old tinder-boxes, however, except that they have a new coat of paint, and the management seems willing to trust to fate to save them from burning down. It must be credited, however, with the fact that during the upheaval of the change, a sketch of each piece was made and the drawings changed to correspond; so if fire ravages through the place, and does not touch the wooden cabinets of the drawing-room, the patterns can be duplicated. Some day there may be a fireproof vault to store a print of each tracing in, but I doubt it.

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FEBRUARY, 1898.

A good expression to remember when considering the theory of steam pumps and injectors, is that used by W. H. Booth in this issue, who says, "The steam pump is, to use a hydraulic parallel, a guide blade and vane turbine. The injector parallels the Pelton wheel."

* * *

Among the book reviews this month, mention is made of two books which, in one respect at least, are notable. We refer to "The Strength of Materials," by Merriman, and the second volume of Jamieson's "Text-book on Applied Mechanics," which contains chapters on the strength of materials. These books are notable because they bring a clear and reasonably complete presentation of the subject of the strength of materials within the reach of those who have not the mathematical training necessary to master the more advanced works on the subject—and, so far as we know, all the really good works have been of this character. These two books, moreover, were written by two men, one of whom (Professor Merriman) is one of the most competent authorities on the subject in this country, and the other is a successful and well-known professor in a technical college in Great Britain. We are indeed fortunate in having two such works by the best writers.

* * *

If we were to suggest to anyone a course to pursue in the study of the strength of materials, we should say to obtain both of the books mentioned above. When studying by oneself it is a good plan to have two books on any subject, as they supplement each other. What one does not contain the other is likely to, and if a certain explanation is not clear in one book, perhaps a hint may be obtained from the other which will clear up the difficulty. In order to understand these books the student must have a knowledge of elementary algebra and trigonometry, but that is all the mathematics required. After he has finished them he will then be prepared to investigate further in the subject if he wishes to. But after all, how much further does one engaged in mechanical work need to go? Calculations regarding stresses and strains enter into machine design only to a limited extent, and when they do occur, they are mostly of a simple nature. It is always startling to a college student to find how little attention machine builders pay to strength and deflection, and it is often discouraging to him to find of what great value is sound judgment regarding stiffness and the proportioning of wearing surfaces. We should advise our student to continue his studies in the strength of materials as far as possible, because at times a thorough knowledge of the subject is of great assistance; but he will not be very badly off if he does no more than to complete the two books mentioned, especially if he has a Kent's pocket-book by his side, as he should have.

DON'T TURN DOWN THE DRUMMER.

One of our friends, who drums the brass manufacturing concerns, called recently at the office of a certain firm which he had not before visited. On stating his business, he was politely informed that the factory was on the top floor of the building and that if he wished to go up and see the superintendent he might do so.

The drummer was properly grateful and after expressing his thanks started up the stairs (as there was no elevator), and after climbing five or six flights found himself in a machine shop, with no signs of brass manufacturing anywhere. On inquiring for Mr. ———, the superintendent, he was informed that this was not Jones' brass shop, but Robinson's machine shop, and that Jones' brass shop was on the first floor, just back of the office.

It is not necessary to state that the drummer did not stop on the first floor on his way out.

Looking at this one way there is a certain amount of humor connected with it; but, seriously, we do not think it is of a kind that will redound to the good of Jones, who runs the brass shop, in the long run. It is not business to induce a drummer to climb five or six flights of stairs for nothing, and there are so many ways in which the drummer can "come back on" Jones and all the rest who think that the drummer is "fair game," that it is a risky way of amusing one's self. If this drummer is asked his opinion of Jones' brass goods (and he is likely to be asked this any time he is on the road), he must be much more than human if he puts himself out to give Jones and his goods a good recommendation.

Anyhow, the drummer is trying to earn an honest living, is therefore to be respected, and is entitled to courteous treatment. What is more, he can, and usually will if treated right, give "points" of more value than the time given to look at his samples.

STEAM BOILER EFFICIENCY.

In the "How and Why" column in this issue a correspondent wants to know about the value of a certain device for improving the efficiency of steam boilers. This is a question that often has to be decided with regard to some one of the numerous devices that are offered, and in doing so it is well to bear in mind a few simple facts about the efficiency of steam boilers.

In deciding upon the merits of any device, it should be remembered that the efficiency of the best boilers, when working under the best conditions, and without any coal-saving attachments of any sort, does not fall far below 80 per cent. The theoretical heating power of anthracite coal is sufficient to evaporate not more than 15 pounds of water from and at 212 degrees per pound of combustible, and no competent engineer would hesitate to install a boiler and guarantee it to evaporate 11 pounds, giving an efficiency of about 73 per cent. Thus there is not a very wide margin for improvement in the best boilers.

But where there is one boiler having a high efficiency under ordinary working conditions, there are fifty that have not, and it is these that it would naturally be wished to improve, except in the case of large plants, where a small gain at each boiler would make a large total gain.

To get the best results from a boiler, the temperature of the flue gases at the point of leaving ought not greatly to exceed the temperature of the steam. When the flue temperatures are high it generally indicates that the heating surface is either too small or else is inefficient.

One should not jump at the conclusion from this, however, that the greater the heating surface, the more efficient the boiler. Enough heating surface is enough, and where the rate of combustion does not exceed 10 or 12 pounds of coal (anthracite) per square foot of grate area per hour, it is seldom that a ratio of heating surface to grate area larger than 35 to 1 will produce much, if any, increased evaporation. With bituminous coal this ratio should be increased to perhaps 45 to 1, and with forced draft more yet may sometimes be of benefit.

Quite as important as the quantity of heating surface is its quality. It should not only be well placed, but it must be so placed and of such a nature that it can be kept clean. No less an engineer than F. W. Dean bases his preference for certain types of boilers on this point alone. Surfaces that are not, or that cannot be kept clean are of greatly decreased value as heating surfaces.

* * *

Our contributor, Mr. F. W. Clough, objects to the position in which the draftsman placed the dimensions upon the sketch illustrating his article "Bevel Gear Formula," last month. Mr. Clough believes that a man should neither have to turn a drawing nor seriously strain his neck, when reading dimensions, and to that end has long advocated the placing of all dimension figures right side up with the bottom of the sheet, without regard to the direction of the dimension lines, instead of the common way of having part of the dimensions read from the right of the sheet. As in all reforms—if this is one—the public are slow about taking up the idea. Right or wrong, there seems to be a natural inclination to place inscriptions so that they follow the line, and we have blindly followed the inclination.

"COMFORTS AND CONVENIENCES."

"Personally, I desire to place around those in my employ every comfort and convenience. This is but a humane step, yet it is found to be profitable, because labor so treated is more intelligent, more faithful, more reliable, and the work turned out is more satisfactory, finds better markets, at better prices."—(Extract from an address delivered by J. W. Vancleave before the Manufacturers' Club of Detroit.)

"Comforts and conveniences" are desirable, and we know from experience that they pay. It would pay in dollars and cents to have every shop in the country light, clean and warm—warm, not only in the afternoon, but warm all day, beginning at seven o'clock in the morning. Lunch rooms, coat rooms and wholesome lavatories are always appreciated; but, after all, these improvements do not count for much unless they are accompanied by just and considerate treatment on the part of those in authority.

The modern and up-to-date company may have every comfort and convenience known to this advanced age; but if the managers show a disposition to always get the best of the bargain in their dealings in the shop, any mechanic would rather work where there was more dirt, but otherwise more congenial surroundings.

To be worth the most to his employers, a mechanic must feel satisfied with his surroundings not only, but with the motives underlying the management, and it is strange that so many fail to appreciate this fact. If there are 100 men in a shop and they feel that there is cause for doing so, there will be 100 men scheming ten hours a day to hold their own, and their work will not be nearly so profitable. Moreover, so much depends upon a man's dexterity and ability, even on machine work, that he will inevitably accomplish less if he is dissatisfied, even if he try to do his level best.

There is another side to this question, however. There ought to be fair dealing both ways. A certain shop used to allow fifteen minutes leeway in the morning—that is, a man could be fifteen minutes late and not be docked, although of course he was expected to be on time. Taking advantage of this, some were habitually fifteen minutes late, and now the rule has been abolished. It does not pay to be grasping where there is no cause for it.

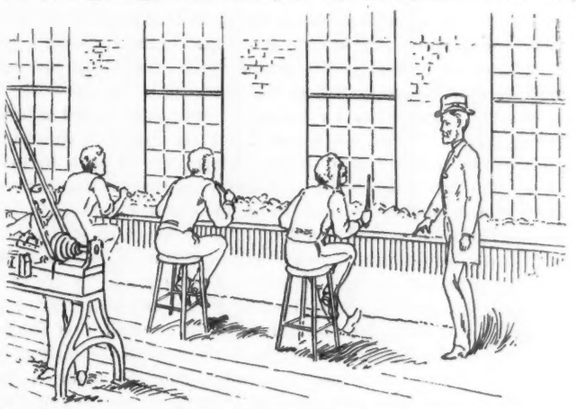
THE INDEPENDENT HOSE COMPANY.

Every shop of any size has sooner or later the Independent Hose Company craze; the shop buys the hose and the hose carriage and builds a nice little hose house (which sooner or later is hedged around by piles of old flasks, etc., so that even if the hose house itself got afire it would burn to the ground before the hose carriage could be rescued—but never mind that now).

A foreman for the hose company is elected, and semi-weekly drills are held, until it is perfectly evident that no fire could get any headway in that shop.

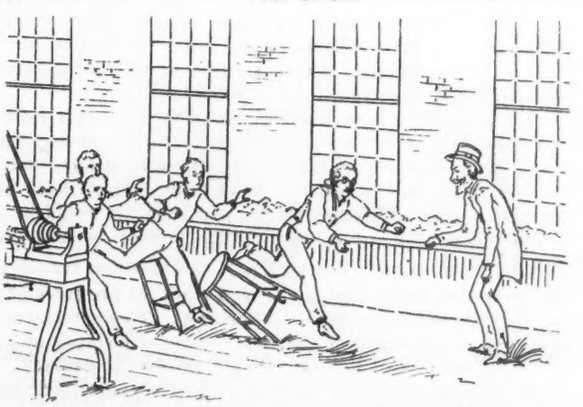
About the time that everybody has forgotten that there is a hose company, a fire actually breaks out—in the attic of the pattern house, of course, and the roof begins to burn before anyone knows it.

Of course, the partner who made the most objection to going to the expense of a hose carriage is the first one to see the roof blazing, and then it is his turn. He isn't naturally excitable, anyhow; he walks calmly through the shop to where the foreman of the "Independent Hose Company" is sitting at a bench at work; he waits a full minute watching the man work, before he says anything; then he says, very calmly and deliberately



(he always spoke calmly and deliberately, even when opposing the expense of getting the hose carriage):

"I guess——you——better——get out——your——hose——carriage;——there is——a——fire——on——the——roof of the——



——pattern loft!!!"

Then, when the foreman of the "Independent Hose Company" couldn't get at the hose house until the flasks were all moved; and when the flasks were all moved, couldn't find his key to the hose-house door, to say nothing of not having a red shirt anywhere on the premises, and the regular city Fire Department had to be called, was the man who didn't want to put the money into a hose carriage indeed avenged.

SLOW PAY.

* * *

New York may not secure rapid transit under ground right away, but the writer learned of a good example of it above ground the other day. A large load of brick was drawn up alongside of one of the tall steel structures in process of construction. Instead of dumping the bricks, the horses were unhitched, and bricks, cart and all were hoisted to the eighth floor, above the heads of wondering passersby, and there the bricks were unloaded, thus saving one handling.

THE PRINCIPLE OF THE INJECTOR.

W. H. Booth.

To young engineers who have not had the advantage of a technical education and are not thoroughly at home in thermodynamics, the action of the injector is somewhat peculiar. The injector is really a heat engine; that is to say, it works by the conversion of heat, which is one form of energy, into motion, which is another form of energy. This is a bald statement of fact. The thermodynamic man will give you the correct explanation of the working of an injector or any other heat engine, and will use many formulæ and confusing symbols. His statement may be true, but it is uninstructive to many minds, and conveys as little information to the non-mathematical mind as the bare statement of the sun's distance from us. When injectors all worked with live steam, they were regarded somewhat as a paradox, for they drew their working steam from a boiler and delivered a jet of water into that same boiler at a point below the surface of the water, where the pressure was a little fraction higher than at the place where the steam was drawn out.

I am by no means sure that the once common belief that there was no pressure in the water space of a boiler did not receive some of its support from the working of injectors, which otherwise would be actually forcing water into boilers against a pressure superior to that of the steam which was doing the work. The injector was tolerated, in fact, because it did its work; but it was not regarded as an altogether straight-forward machine, for it had no moving parts, and it did not appeal to those of us who had been accustomed to the performance of work by means of mechanism. But when it was found out that an injector could draw its working steam from an engine exhaust pipe, open freely to the atmosphere, and could thereby be made to feed a boiler containing a pressure of 70 pounds of steam, it became evident that all was not right. Men would go outside to see if the exhaust pipe were not closed, so as to get some pressure. The indicator was called in, and only told us, after all, that the back pressure on the piston was a trifle reduced when the injector was at work. Everything was apparently done to make it more difficult for the thing to go, and it went all the better. Thus its steam supply was taken off at a square bend from the exhaust pipe, and the instrument found it a benefit. This was found to be due to a very simple and long-known law that bodies in motion tend to remain so and to move in straight lines. Thus the oil and water particles in the steam rushed on in a straight line and had no power to move laterally into the branch pipe, which snatched, so to speak, only dry steam. The principle underlies all steam and water separators yet made. It was, then, the exhaust injector which led practical men to ask for the reasons underlying injector action.

Clearly we must have a knowledge of facts, so that we may use these facts to explain what seems so curious at first sight. Experiments have shown that steam flowing from one vessel to another has a certain velocity. Many curious facts have been brought out by such experiments, into which it would be out of place to enquire at this present time. One of the rules given for the flow of steam is $V = 1{,}200\ \sqrt{P-p}$ where V is the velocity of flow in feet per second, and P and p are the pressures of the vessels from and into which the steam flows. These pressures are measured in feet length of a vertical column of mercury, and are measured from zero; that is, they are absolute pressures.

The pressure of exhaust steam is, of course, atmospheric only; that is, it has an absolute pressure of 2½ feet of mercury, or 30 inches. The water discharged by an exhaust steam injector will sometimes have a temperature as high as 190 degrees, and this temperature about corresponds with a pressure of 18 inches, or 1½ feet of a mercury column. Hence, $P - p$ is simply 2½ — 1½, or 1 foot, and the square root of 1 is 1, so that the flow velocity is 1,200 feet per second. This probably understates the actual velocity, but is, for the present, sufficient for our purpose. Steam outflow is also given at only about three-fourths this velocity. To be on the safe side, we will take it at the lower figure of 888 feet per second. To endeavor to get a plain understanding, let us take actual known facts. We know that an exhaust injector will regularly feed against a pressure of 70 pounds gauge. A pressure of 70 pounds is equal to a head of 161 feet of water, and water flowing under this head has a velocity $V = \sqrt{2g\,H}$ where H is the head and g is gravity, or say 32. The square root of H is nearly 13, and the velocity due to 161 feet is thus nearly 104 feet per second, or less than one-eighth the velocity of the exhaust steam jet at a low estimate of this latter. Thus if one pound of steam at 888 feet mix with 7 pounds of water at no velocity, the result will be a mixture of 8 pounds of warm water at the mean velocity of the two jets, or 111 feet per second, this being one-eighth of 888. This combined jet moving at 111 feet per second has thus a greater energy than a jet of equal size coming from the boiler at only 104 feet velocity, and the more rapid jet would overcome the slower one, and would be able to enter the boiler.

We see, therefore, that given certain proportions of mixture the action of the injector is easily explained. But do our figures tally with other known facts? There is the fact of the jet having a temperature of 190 degrees. Exhaust steam has a total heat of 1,178 units and it loses temperature in mixing with cold water, so that it loses in its heat content 1,178—190 or 988 units. This heat the cold water gains.

Say the water starts at an ordinary temperature of 60 degrees, then 190 degrees — 60 degrees = 130 degrees, is the rise of temperature of the water. The number of units lost by the steam, divided by the heat gained by the water, or $988 \div 130 = 7.6$, is the ratio of water to steam; so that one pound of steam will heat 7.6 pounds of water to 190 degrees. This so nearly coincides with the ratio of 7 already found on the basis of velocity that with the roughness of our figures the two may be considered to check one another even at the lowest estimate of velocity of flow of exhaust steam.

Any higher ratio of flow would leave so much margin of better efficiency and we can hardly expect that the injector is perfectly efficient. There is some eddying and some friction in the cones, but there is every reason to look on the injector as a very fairly efficient implement. Indeed, if it has any lack of perfect mechanical efficiency this is all recovered in heat. Any lack of efficiency is due to friction in the instrument itself or eddies, and both the eddies and the friction developed heat are carried forward into the boiler. As a whole there can be no loss by using the injector. Its efficiency only falls short of 100 per cent. of the amount of heat lost in radiation from the body of the injector or pipes, and this can be reduced by protection if desired. At most it is trifling. If, then, the exhaust injector will work so well it is easy to see that the so-called live steam injector will work better. The velocity of the steam jet is greater and there is not much more total heat to get from the steam to the water. Further, the water can be more highly heated, because hot water acts as a condenser to hotter steam, and the live steam injector may everywhere be hotter than 212 degrees, and the steam will condense in the moving jet of water, which has an energy of motion such that it is the equivalent of a closed vessel under pressure, and so can condense any steam pushed into it, if this is at a pressure corresponding to a higher temperature.

In most heat engines we have become accustomed to such details as pistons and rods, and so on, and do not so readily appreciate the case of heat engines without pistons. We easily understand the steam pump forcing a jet of water by the use of low pressure steam upon a piston larger than the water piston. The injector really acts on the same lines could we but see it. In one case steam acts by its pressure on a piston. In the other it acts by attaining velocity due to heat energy of expansion.

The steam pump is to use a hydraulic parallel, a guide blade and vane turbine. The injector parallels the Pelton wheel.

* * *

The following story is told, by the New York "Sun," of Engineer Simpson, one of the veterans of the Maine Central service. One summer when Wm. K. Vanderbilt's car was at Mount Desert ferry, the general manager of the Maine Central sent a locomotive down there to take the car to Portland, whither the millionaire desired to go. Simpson was the engineer, and he pulled the car along towards Portland at a surprising rate of speed. At Brunswick a stop was made for water, and while Mr. Vanderbilt got out and requested the old engineer not to drive so fast. Simpson eyed the nabob a quarter of a minute, and then replied: "I am running this under orders from Payson Tucker to be in Portland at 1:07. If you want to stop here, all right; if you want to go to Portland, get in." Mr. Vanderbilt got in.

SHOP TALKS WITH YOUNG MECHANICS—2.

THE FILE AND FILING.

W. H. Van Dervoort.

A piece of high-grade crucible steel, forged to shape, ground, cut and carefully tempered, forms that tool so indispensable to the mechanic—the file.

The file maker is no longer compelled to forge his blanks from stock of unsuitable proportion, but receives from the steel manufacturers stock of the required cross-section to make all standard shapes. This reduces the forging to a minimum, it being only necessary to cut the stock to the required lengths, to draw down the point and form the tang, the latter operation being very rapidly performed under power hammers.

The National Association of File Manufacturers prescribe to the steel makers the forms of cross-sections they require. Consequently, all makers of file steel can furnish any section correct to gauge. In Fig. 13 are shown the correct cross-sections of steel for flat files, even inch lengths, from 4 to 16 inches. In Fig. 14 are shown the cross-sections of file steel for all the shapes in general use. Each section is for an 8-inch file, full scale. The names of the files made from steel of these sections are, referring to the numbers of the figure: 1, "Hand"; 2, "Flat"; 3, "Mill"; 4, "Pillar"; 5, "Warding"; 6, "Square"; 7, "Round"; 8, "Half-round"; 9, "Three-square"; 10, "Knife"; 11, "Pit-saw"; 12, "Crossing"; 13, "Tumbler"; 14, "Cross-cut"; 15, "Feather-edge"; 16, "Cant-saw"; 17, "Cant-file"; 18, "Cabinet"; 19, "Shoe-rasp"; 20, "Rasp."

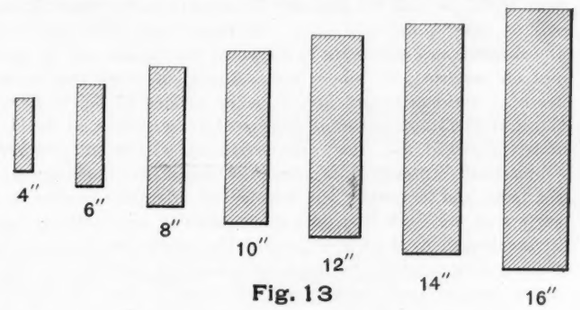


Fig. 13

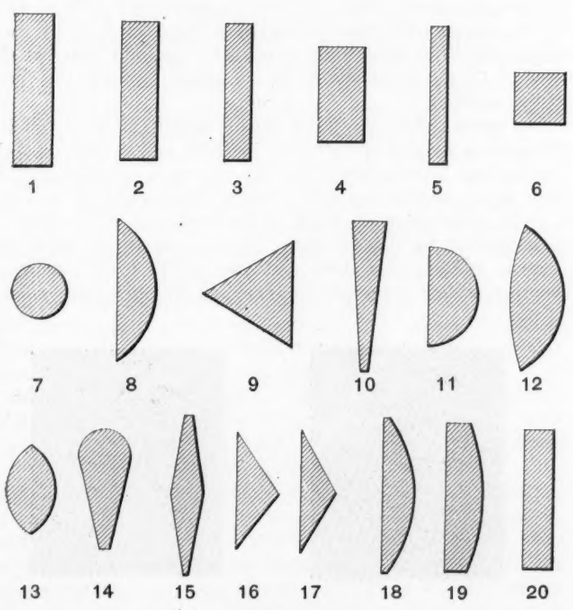


Fig. 14

It will be noticed that many of these files are named from the form of their cross-section, and that those so named are the ones most used for general work; while the others receive their names from the special character of the work they are expected to be used upon. It will also be noted that the stock for files of rectangular cross-section may be classified as to thickness as follows: "Square," the thickest; "Pillar," "Hand," "Flat," "Rasp" and "Warding." As to width, "Hand" is the widest; "Flat," "Rasp," "Mill" and "Warding" are the same width; "Pillar" materially narrower, and "Square" the narrowest.

The "Half-round" is not a full semi-circle, the arc being about one-third of the full circle. On the other hand, the "Pit-saw" is a full half circle in section.

The "Three-square," "Cant-saw" and "Cant-file" differ in section in their angles, the former having equal angles, 60 degrees, and equal sides, the next 35—35 and 110-degree angles, and the latter 30—30 and 120-degree angles.

The length of a file is measured from point to heel, and does not include the tang. The tang is usually made spike shaped to receive a plain ferrule handle. Some makers modify the form of tang to fit patented handles.

As forged, the blank for a "Hand" file, Fig. 15, is parallel in thickness from heel to middle and tapered from middle to point, making the point about one-half the thickness of the stock. The edges of the blank are usually left parallel. They are, however, sometimes drawn in slightly at the point.

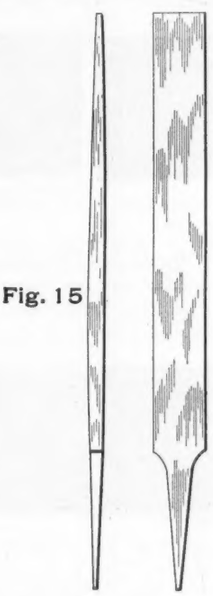


Fig. 15

Fig. 16

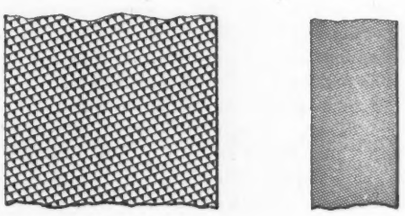


Fig. 17

The "Flat" file blank, Fig. 16, is parallel in both of its longitudinal sections from heel to middle and tapered in both sections from middle to point, the thickness of point being about two-thirds and width about one-half that of the stock.

For the "Mill" file the blank is parallel in thickness from heel to point, and usually tapered to about three-fourths the width of the stock. The "Mill" file is often made blunt—that is, of equal width and thickness throughout its length.

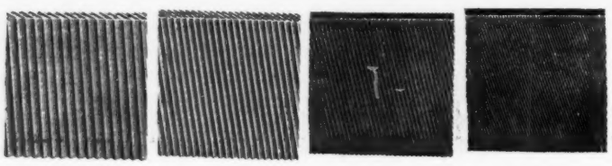
The blank for the "Warding" file is tapered in width from heel to point and is of uniform thickness. Aside from width, the "Pillar" file is similar to the "Hand" file. The "Pillar" file is also made in "narrow" and extra narrow patterns, the extra narrow approximating a square in section.

The "Three-square," "Square" and "Round" are also made in slim and blunt forms. The "Slim" is a file of regular length, but smaller cross-section, and the "Blunt" of equal cross-section from heel to point, being either "slim" or regular.

After forging, the blanks are thoroughly annealed in annealing furnaces, the operation taking from twenty-four to thirty-six hours. When the blank comes from the furnace, it is twisted and scaly, and must be subjected to a "straightening" process, after which the scale is removed by "grinding" on very heavy grind-stones. The blanks are next draw-filed to make them perfectly smooth and even, after which they are ready for the cutting.

Files are classified under three heads—"Single-cut," "Double-cut" and "Rasp." The "Single-cut" file—or "Float," as its coarser cuts are sometimes called—has surfaces covered with teeth made by single rows of parallel chisel cuts extending across the faces at an angle of from 65 to 85 degrees with the length of the file. The size of this angle depends on the form of the file and the nature of the work it is to perform.

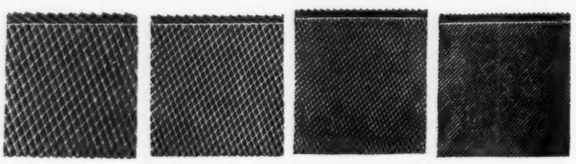
The "Double-cut" file has two rows of chisel cuts crossing each other. The first row is, for general work, at an angle with the length of the file of from 40 to 45 degrees, and the second



COARSE. BASTARD. SECOND CUT. SMOOTH.

FIG. 18. SINGLE CUT.

row from 70 to 80 degrees. In the "Double-cut" finishing files the angle of the first cut is about 30 degrees, and the second from 80 to 87 degrees with the axis of the file. The "Double-cut" gives a broken tooth, the surface of the file being made up of a large



COARSE. BASTARD. SECOND CUT. SMOOTH.

FIG. 19. DOUBLE CUT.

number of small, oval-pointed teeth inclined toward the point, and resembling in shape the cutting end of a diamond pointed cold chisel.

In the rasp the teeth are entirely disconnected from each other. They are round on top, and are formed by raising, with a punch, small portions of stock from the surface of the blank. The machinist seldom has use for a rasp, as they are intended for filing the softer materials, as wood and leather.

The regular grades of cut upon which the coarseness of a file depends are "Rough," "Coarse," "Bastard," "Second-cut," "Smooth" and "Dead-smooth." The "Rough" file is usually single cut and the "Dead-smooth" double cut. The other grades are made in both double and single cut. These grades of coarseness are, however, only comparable when files of the same length are considered, as the longer the file in any cut, the fewer the teeth per inch of length. This is shown in Fig. 17, where a 4-inch and 12-inch "Bastard" file are placed side by side for comparison.

The relative degrees of coarseness for the different cuts are shown, for the "Single-cut" in Fig. 18, and the "Double-cut" in Fig. 19, a portion of an 8-inch file being taken in each case.

The value of a file depends entirely upon three things—quality of stock from which it is made, the form of its teeth and the temper. The stock should be of the very best, as tool steel is seldom put to any use where its lasting qualities are more severely taxed.

As to the forming of the teeth: It is only within the past few years that machine-cut files have come prominently upon the market, it being generally believed that a file to be first class must be hand cut. In Fig. 20 are shown portions of two 14-inch flat "Bastard" files; of these one is hand and one machine cut. The difference between these cuts is so slight that only an expert, with the files rather than their pictures before him, could tell, with any degree of certainty, which was the hand and which the machine cut.

Up to the time of the perfecting of the increment cut file, the great trouble with machine-cut files was in the perfect uniformity of the teeth. In a hand-cut file the width and spacing of the teeth depend entirely upon the skill of the workman; and no matter how carefully he does the cutting, irregularities of a thousandth of an inch, more or less, will occur in the spacing and in the angle at which he holds the broad chisel that forms the teeth. These slight variations will cause the teeth to be of uneven height and irregular outline. These irregularities are now very faithfully reproduced in the increment, machine-cut file.

It is difficult to make a file having teeth of uniform height and outline, as in the case of the ordinary machine-cut file, take hold of the work. The reason for this is that so many teeth present themselves to the work surface that the workman must exert great pressure on the file to make them bite. With the file having teeth of irregular height, fewer will come in contact with the work, and the pressure required to make them take hold will be correspondingly light. As these long teeth wear down, the shorter ones will begin to do work; but the file will, of course, not cut so freely as when new. Again, in using the file with teeth of uniform height, it will, when pushed to the work, produce, at the start, grooves which will grow deeper as the file is moved forward, and, due to the broad cut, will be quite certain to vibrate and "chatter." On the other hand, the uneven teeth of the hand and increment cut files will so adapt themselves to the surface of the work that only a few teeth at any particular point in the length of the file will cut. The metal left between these teeth will be removed by the teeth following, perhaps a dozen or more rows of teeth being required to finish the cut started by one. This is shown, for a "Single-cut" file, in Fig. 21, where the several irregular lines represent as many tooth outlines drawn on an exaggerated scale. These teeth come successively to the work, and if all their high points were brought together they would form a straight line, as shown, which would be the outline of the resulting cut.

The cutting of an increment cut file consists in the forming of the teeth by a chisel operated in a machine, and so controlled that the spacing between teeth may be increased or decreased, the same being subject to a small amount of irregularity, as well as a slight variation in the angle of the teeth with each other. As manufactured by one company, the spacing of the teeth from point to middle is increased, and from middle to heel decreased. Another leading manufacturer increases the pitch from point to

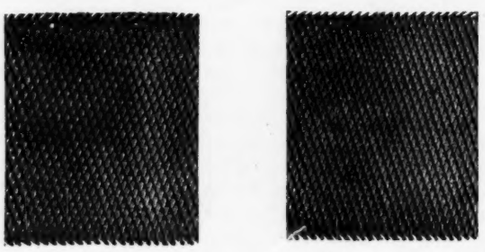


FIG 20. HAND AND MACHINE CUT.

heel. It will be understood that the increment of space is very small. In a 12-inch "Bastard" file, having teeth spaced progressively wider from point to heel, the pitch of teeth at heel is about .01 of an inch greater than at the point, which makes the average increase per tooth about .000030 of an inch.

In machine-made files the cutting is very rapidly performed, the chisel receiving from 500 to 3,500 blows per minute, depending on the weight of the file being cut. The blank is cut from point to heel, and when turned over is placed on lead strips to protect the teeth already formed.

After cutting, the files are inspected and assorted as to quality. They are then tempered, any material change in shape due to hardening being rectified at the time of tempering, after which they are ready for final inspection. This consists of trying each file on a piece of hard steel and making sure that it is free from temper cracks. They are next coated with oil and wrapped in oiled paper, to prevent rusting, after which they are packed in boxes, ready for the market.

The teeth of a file remove metal by a shearing cut. This is most apparent in the "Single-cut" files, where the teeth have lateral length; but is equally true of the pointed tooth of the "Double-cut" file.

A file bites freer on work having a narrow surface than a wide, because fewer teeth come in contact, at any point in the stroke, with the work surface, and consequently less pressure is required to make the file bite. On very thin work the teeth of a "Double-cut" file bite so freely that the danger of breaking them is great. For work of this character the long tooth of the "Single-cut" is best adapted, as its form gives it greater strength, and the shear of the cut is smoother, one tooth coming into cut as another leaves. On the broad surfaces, however, the teeth of the "Double-cut" have the advantage.

When the file is pushed endwise across the work, it is called cross filing. The work is performed on the forward stroke and the file released from all cutting duty on the return stroke. It should not, however, on the return stroke be raised from the work, except at such times as may be necessary to examine the condition of the surface. As the file is pushed forward, it should be given a slight side motion, and after a number of strokes the direction should be changed, so as to make the file marks cross at quite an angle. This will increase the cutting of the file, and will keep the work true by preventing deep grooving.

The handle of the file in cross filing should be held in the right hand, preferably with the end of the handle seated against the palm and the thumb extended along the top. The point is held under the ball of the left thumb, the fingers pressing upward

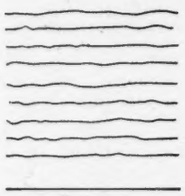


Fig. 21

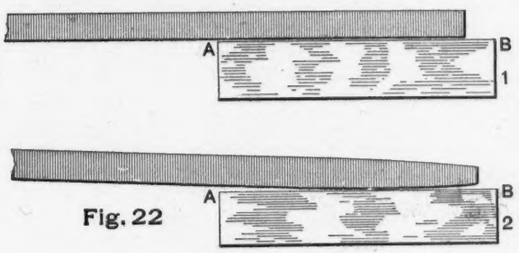
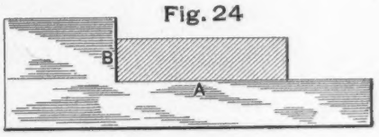


Fig. 22

Fig. 24



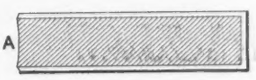


Fig. 25

A file is "tapered" when it is thinner at the point than at the middle, and is "full tapered" when thinner at point and heel than at the middle. The reasons for thus tapering a file are, first, to reduce the number of teeth that come in contact with the work, and, second, to enable the operator to file a straight or plane surface. The first reason is evident; the second is shown in Fig. 22. If the file is perfectly straight, as shown in 1, the motion in order to produce a plane surface on the work must be absolutely parallel to this surface. This the most expert mechanic can scarcely be expected to do, and the result will be work rounded at the edges *A* and *B*. If the file is tapered, its surface will be slightly convex, as shown in 2, and if moved entirely across the surface, straight work will result. The workman will experience little difficulty in accomplishing this, as he can allow the motion of the file to deviate slightly from a straight line, and still not cut away the edges *A* and *B*. If the file is not moved clear across the work, a concave surface will of course result.

The tempering is certain to distort the file somewhat, and it will, as a result, usually be found to have more "belly," as this convex quality is called, on one side than on the other. It is the side having the most "belly," and the highest part of that, that the careful mechanic will always select for use in his most particular work. This high point he readily finds by running his eye along the edge of the file from point to heel.

In filing the non-fibrous metals, as cast iron and brass, sharper files are required than for work on steel and wrought iron. Broad surfaces require, as indicated above, sharper files than narrow ones. The systematic workman will therefore use his new files on broad surfaces of cast iron and brass, next on the narrow, and when dulled to such an extent as not to readily take hold of these metals, he will use them for work on wrought iron

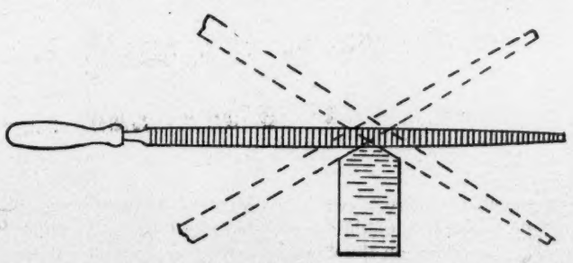


FIG. 26.

and steel, and finally, when too dull for efficient work, may be used for smoothing up and removing the hard scale from castings and forgings.

A new or good file should never be used on rough castings, as the scale of cast iron is often very hard, and will ruin the file after a few strokes. The edge of the file can be used to adavantage for this work, as it is seldom used for other purposes.

against the lower side. In using thin files the downward pressure at heel and point may spring them until they are concave instead of convex to the work surface. In this case the point must be so held between thumb and fingers that the fingers exert an upward pressure under the point and the thumb a downward pressure a few inches back from the point, which will tend to make the file more convex to the work surface. It is a tiresome way to hold the tool, but will at times be found necessary.

FIG. 23.

When the surface of the work is broad, a surface holder must be used. Fig. 23 shows a device much used for this purpose.

In filing broad surfaces the work should be placed low, thus enabling the operator to reach all points of its surface and to put the required pressure on the file. For work held in the vise or on the bench, the surface being filed should be at about the height of the workman's elbow, so as to give the forearm holding the file handle a nearly horizontal motion. If the work is fine and delicate, it is preferable to hold it higher, as it can then be more readily inspected.

In draw filing the motion of the file is at right angles to its length. It is firmly held in both hands at heel and point, the handle usually being removed. In draw filing the metal is removed much slower than in cross filing, with the same cut of file; but the surface left is smoother, is not so apt to be scratched in the operation, and will take a better finish. Draw filing requires less skill than cross filing, the beginner being able to produce very creditable work after comparatively little practice. Cross filing, on the other hand, requires skill and experience when smooth, plane surfaces are to be made.

The character of the work and the surface required will determine the coarseness of the file the mechanic will select for performing it. The "bastard," "second-cut" and "smooth" are the cuts most used by the machinist on general work. The "rough" and "coarse" cuts are used mostly on the softer metals where a large amount of stock is to be removed quickly. The fine-cut files will take hold of the harder metals better than the coarser files, and will leave the surface smoother.

The file must be kept free from the cuttings which lodge between the teeth. When lodged too firmly to be removed by tapping the edge of the file against the vise back, they should be scraped out with a soft wire file card or brush. When working on wrought iron or steel, cuttings will lodge so firmly that they cannot be brushed out, but must be picked out with soft iron scorer. They will often project above the teeth and cause deep scratches in the work. This annoying trouble is called "pin-

ning." It may be lessened somewhat by thoroughly chalking the surface of the file, which also prevents its cutting so freely.

When filing work in a lathe, care must be taken not to run the surface filed too fast. It must be remembered that, ordinarily, the motion of the file to the work is comparatively slow—say, forty strokes per minute, of perhaps 8 inches each. As the file is cutting only about one-half the time, the actual velocity of cut in this case would be not far from 50 feet per minute. The intermittent motion of the cut prevents the teeth becoming extremely hot. In filing revolving work, the number of strokes per minute will not be so great, but the length of stroke will be somewhat increased; so the actual cutting speed due to the motion of the file will not be much less than in cross filing. To this must be added the speed of the work, which will vary from 50 to 100 feet per minute. It will be understood that, in filing stationary work, a comparatively short length of the file's surface is cutting, whereas in filing rotating work, nearly all of the file's length is brought into use at each stroke, which offsets largely the disastrous effects on the teeth due to too high a cutting velocity. The file must not be held stationary, allowing the work to revolve to it, as in that case a few teeth do all the cutting and leave a grooved surface. As the file is moved forward, it should, as in cross filing, be given a small amount of lateral motion, first to the right and then to the left, causing the file marks to cross at quite an abrupt angle. Rotating work should be filed as little as possible, in order to obtain the desired finish, it being almost impossible to retain the cylindrical truth of the work if filed too much.

A safety edge on a file is one having no teeth. The safety edge enables the mechanic to file one of two surfaces *A*, intersecting at right angles, without injuring the other *B*, as shown in Fig. 24. The safety edge on a new file should always be passed over a grindstone or emery wheel before depending on its "safety," as in the cutting of the sides the stock is expanded over the edge, making a slight concave, as shown at *A*, in Fig. 25. While the points of the teeth do not, in cutting, form out full over the safety edge, the roots of the teeth do, and they are very apt to scratch the surface the edge is expected to protect. A very satisfactory safety edge is made by grinding the teeth from the edge of a full cut file.

When a large amount of metal is to be removed quickly, the file may be used at different angles, as shown in Fig. 26. This decreases the area of cut and increases the bite of the file. A new file should never be used for this purpose, as the keen edge of the teeth would be broken off. All work surfaces, especially if narrow, should be held as near the top of the vise jaws as possible, thus preventing vibration.

Good workmen will keep the files they are using in a rack or drawer, so arranged that they cannot come in contact with each other. When we consider the amount of metal a file will remove under favorable conditions, we are impressed with the expense of the tool when improperly used. Far too many are ruined through carelessness.

* * *

The history of the "New Ironsides" was briefly given by Mr. Chas. H. Cramp in a late address before the Contemporary Club, of Philadelphia, and the essential parts of his address are thus reported in the "Engineering News": "This ship was contracted for at the same time that the building of the original 'Monitor' and the 'Galena' was decided upon by a naval board consisting of Commodores Paulding, Smith and Davis. The 'New Ironsides,' completed in 1862, was 240 feet long, 58½-foot beam, drew 15 feet of water, was rated at 3,250 tons and had engines of 1,600 horse-power. Her hull was made of oak frames, solid together on the sides, and covered with 12-inch oak; outside of this were 4½ inches of hammered scrap-iron armor, made at Pittsburgh and at Bristol, Pa. Her armament was made up of fourteen 11-inch Dahlgren smooth-bore guns and two 200-pound Parrot rifles, all muzzle loaders. The contract was awarded to Merrick & Sons, of Philadelphia, for $848,000, and the plans and specifications were made by Mr. Cramp, and the contract for the hull and fittings was sublet to his firm. This battleship was built under great difficulties, with the wood entering into her construction growing at the time of contract and with no precedent in type or special tools ready for the novel demand. Yet, in eleven months and two days after signing the contract this ship was in battle before Fort Sumter.

FROM ACTUAL PRACTICE.

A LESSON IN MILLING FOR THE APPRENTICE.

Milo.

"Tramp Machinist" is not an attractive title, but a tramp machinist is not always to be sneezed at, as some of our best men have learned from their experience with those who have made their appearance in the Hardscrabble shops from time to time. The tip that one of them gave our "dandy tool maker" is characteristic, and was a source of considerable satisfaction to the rest of us, while it was no doubt a much needed lesson for "Dandy."

"Dandy" is a man who learned his trade, served his apprenticeship rather, at the Brass & Nerve Co.'s, and is one of those I-know-it-all sort of fellows who never worked anywhere else these many years to find out that he was mistaken until Mr. Nay hired him a short time ago. Of course, we all know that Brass & Nerve Co. have one of the largest machine shops in the country, and are thoroughly up-to-date, but their men don't "know it all," for if they did, when they come into a shop like this they would know enough to keep still instead of grumbling all the time like a chronic sore-head, because this or that and everything else is not like what they were used to having to work with in the old shop. There is more than one "Dandy."

Well, Nay & Co. got an order a short time ago for some special machines that were considered too complicated for any of the old hands to tackle, so Mr. Nay began to look around for a first-class mechanic, and finally secured "Dandy" to take charge of the work.

"Dandy's" reputation as a skillful all-around workman prevented most of us from saying much in return, but "Tramp" seemed indifferent—never says much anyway.

Among other things to be made for the new machines were a lot of special chucks, made of good steel with T-shaped jaws, and "Dandy" decided to make the tools and construct the chucks himself, because there was a brand new lathe and a small vertical mill-

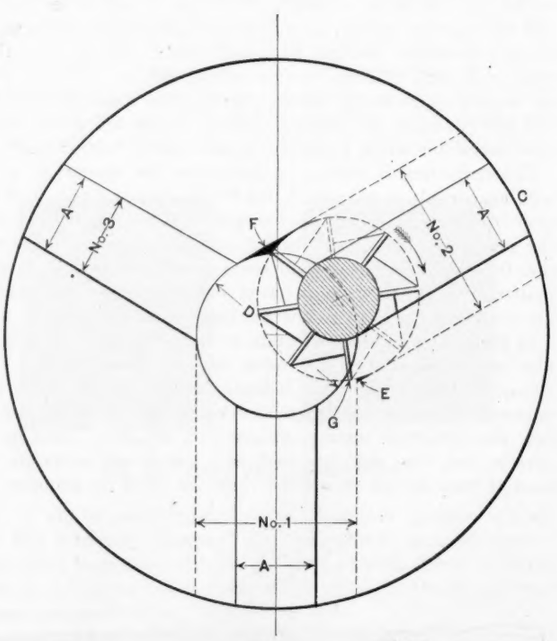


Fig. 1

ing machine for him to work on—some of his own selections—and he probably thought he was the only one in the shop who could make them on the duplicate parts plan, which was one of the important features.

The T-slots for the jaws of the chucks were about ⅝ of an inch deep, ⅝ wide at the bottom, and 5-16 of an inch wide at the top; so the mills had to be quite frail, and he made two dozen of them so as to be sure and have enough, saying that the shop needed a few such tools anyway. One dozen were regular end mills for working out the narrow part of the slot, and the other dozen T-slot mills for finishing out the bottom part.

The new milling machine was one of those made for die sinkers; had an indexed revolving table that could be fed in two directions at right-angles by hand, also a vertical movement to the spindle as well as the table.

When all was ready the milling of the slots in the chucks was begun, and the narrow slot in the first one was made with little trouble. The T-slot cutter was put in and it went through the first time all right and left as good a T-slot as one could expect. The next slot was almost done when smash went the cutter.

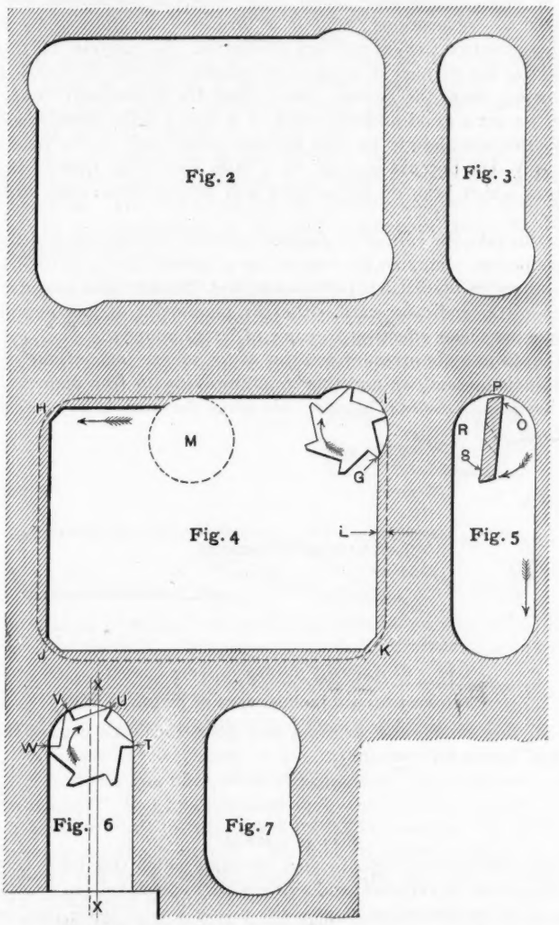


Fig. 4 Fig. 5 Fig. 6 Fig. 7

Another was put in and that chuck was finished, but the smash came again on the next chuck at the end of the second cut also; and the same thing was repeated on each chuck at the same point, until most of the cutters were gone, and the boys began to think the promised stock of T-slot mills was going to be small. Smash went another cutter and "Dandy" began to rave and wonder why those cutters broke, and every one of them at the end of the second cut.

"Tramp" was working near him and decided to give him a tip on the next one. He watched "Dandy" place the next chuck, cut the three narrow slots *A A A*, Fig. 1, and go through No. 1 with the T-slot cutter, stop the machine, run the table back and carefully index it around to slot No. 2, ready to start the second cut, when he stopped him and said:

"Turn that table around the other way and mill No. 3 next just for luck."

He did so and there was no trouble, and the remainder of the lot was done in the same way without breaking a cutter.

There were only three slots and "Dandy" couldn't see what difference it made which one he milled second, until he persuaded "Tramp" to explain it.

Referring to Fig. 1, *A A A* were milled out almost full depth. Beginning at the outside of the chuck, the T-slot cutter was fed in through slot No. 1, enlarging the bottom, as shown by the dotted lines. By turning it around and starting the cut at *C* it would work all right until it came to the position illustrated, when, owing to the stock removed by the previous cut and the hole *D* through the chuck, there was, as shown by the black spots *E* and *F*, much more stock to be removed at *F* than at *E*. As soon as the tooth *G* passed the point *E* the cutter was doing no work on that side, and turning in the direction indicated by the arrow, pulled the table forward to the extent of the backlash in the feed screw, caught between *E* and *F* and was broken. But if No. 3 was finished second the bulk of the stock was left on the other side of the mill, which prevented the work from being drawn in by forcing it the other way instead. Then when it came to finishing No. 2 there was an equal amount of stock on each side, same as there was in the first, and with proper care gave no trouble. Strange, isn't it, that such a little thing should bother a man like "Dandy?"

Machine work is full of just such troubles, that are often considered incurable, when a thoughtful, observing mechanic would be cheap at almost any price, if the company would only see it in that light.

The shaft in the new machine had to have a key set into it, and the job fell on "Tramp." Since the cutter he made for the work was new to "Dandy," it may also be new to others.

When a slot or recess is enlarged with an ordinary end mill there is usually a jog at each end or corner, as shown in Figs. 2 and 3, caused principally by having too many teeth in the mill.

Laying out the recess *H, I, J, K*, Fig. 4, with stock *L* to be removed, and starting the cut at *M*, the tendency is to spring away from the work into the vacant space, the effect of which is often largely overcome by taking light chips and fine feed. But when it comes to the corner *J*, about double the number of teeth are cutting, and the strain they bring upon the mill more than counteracts its previous tendency to deviate from its normal position. The result is that it crowds into the work and makes the jog shown at the corner, and the same thing is repeated at

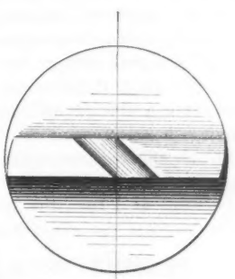
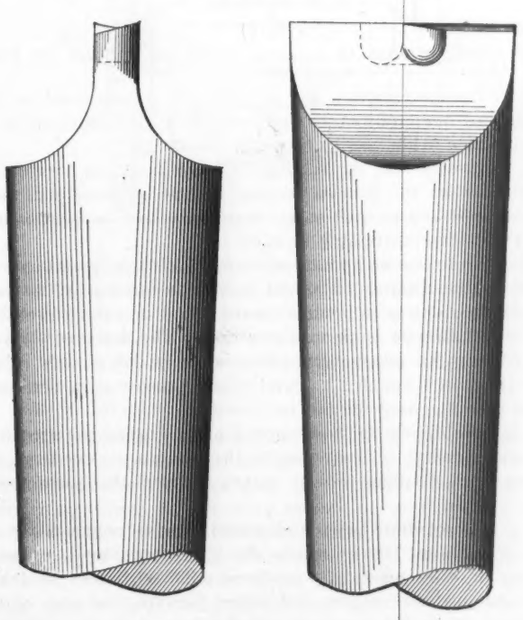


Fig. 8



each of the corners in succession. Now, if there were no teeth on the side *H I* to do any cutting when the mill was crowded over there, it would not cut away the stock. *G* should finish its cut before another tooth begins, and on a job like Fig. 2 three teeth would probably work all right, but two are as many as can be used in a slot of the same width as the diameter of the mill and avoid the trouble. Sometimes a mill that runs out so badly that the strain upon it is not sufficient to spring it enough

to make more than one or two teeth do any cutting will do very good work, and a mill with all but one or two teeth broken is often better than a brand-new tool, although frequently rejected by men who do not stop to consider these points.

The one "Tramp" made had only two teeth, and, as Fig. 8 shows, is a very simple affair. Such cutters are quite extensively used in some shops, while they are entirely unknown in others. Some call them cotter mills.

In making a slot with one of these mills, the spring is towards the side *R* (Fig. 5) when the tooth *O* is at *P*, but there are no teeth at *R* to cut, and when *S* gets around to begin work the strain on the mill has been removed by *O* having finished its cut, and the result is a slot central with the normal position of the mill and free from the jogs at the ends.

In cutting a slot from solid stock with an ordinary end mill, the work done by the teeth on the side *T U V* (Fig. 6) springs the mill to the left and cuts away the metal at *W*. These positions being taken by one tooth after the other as the mill revolves, the result is a slot to the left of *X*, the normal position of the mill; but as soon as the feed is stopped it begins to work over towards its natural position, making a jog on the right, as shown in the upper end of Fig. 7. Starting from a hole and working through solid stock, the mill will crowd over to the left as soon as the feed is put on, and remain there until the feed stops, when it will return, and a slot like Fig. 7 is the result. If the work is fed to the mill in the opposite direction, the conditions and results are reversed. A left-hand mill springs in a different direction also. A common practice in milling such slots is to make several cuts in both directions, which makes a slot somewhat wider than the diameter of the mill, because the spring operates in both directions; but, with the utmost care, it is almost impossible to mill a slot in this way and get the ends squared up true and straight without having the mill get hold of a chip running the whole depth of the slot, and crowding it over to the side, making a slot something like Fig. 3, which would not be the case with a cotter mill.

Although there is more or less "give" to the machine and work itself, I have considered nothing but the springing of the mill, because, as a rule, the springing of the other parts simply tends to increase the effect described.

HORSE-POWER AND FORMULAS.

J. B. Richards.

PLAN

The usual formula of $\frac{\text{——}}{33{,}000} = \text{HP.}$ is familiar to most engineers and mechanics, and as everyone is interested in the question of horse-power, it will serve as a good subject for a little practice in the use of formulas.

As the proper way to thoroughly understand any formula is to consider all the factors bearing on the problem and their relation to it and to each other, it will pay to take a little time to get this idea thoroughly in mind.

The work any moving force exerts is equal to the pressure multiplied by the distance; 1 pound moved 10 feet equals 10 foot-pounds, the same as 10 pounds moved 1 foot or 2 pounds moved 5 feet; the product is 10 in either case. The accepted "horse-power" is 33,000 foot-pounds per minute; 33,000 pounds raised 1 foot high in 1 minute; 1 pound raised 33,000 feet in 1 minute, or 330 pounds raised 100 feet in 1 minute.

So in considering the horse-power of an engine, we must first find the number of foot-pounds the engine is exerting per minute; then dividing this by 33,000, we have the horse-power of the engine.

Now that we thoroughly understand what is required, we see that the different factors which affect the foot-pounds of work the engine does must be considered. These factors evidently are steam pressure urging the piston forward, the area of the piston on which the steam acts and the distance through which it acts in one minute, or piston speed as it is called.

The piston speed is of course the product of the length of each stroke (in feet) by the number of strokes per minute, and the letters in the formula represent the following:

P = mean effective pressure per square inch on the piston.
L = length of stroke in feet.
A = area of piston in square inches.
N = number of strokes per minute, or twice the number of revolutions in a double-acting engine.

The pressure is evidently less than boiler pressure—in fact, is much less, owing to expansion and back pressure, and is the average or mean effective pressure, as shown by the indicator diagram or by calculation. The length of stroke is known, usually in inches, but can be reduced to feet by dividing by 12.

The area of the piston can be found either in a table of areas of circles or calculated as follows: Square the diameter (multiply it by itself) and multiply the result by .7854, as will be shown later.

The most troublesome factor is *N*, which is sometimes considered as "revolutions," and it is forgotten to multiply by 2, as there are two strokes to every revolution. By considering this always as the number of strokes per minute, this can be avoided. Knowing, then, the factors which affect the horse-power question, we get a good understanding of it, and a little thought will make the rule plain to us—not because of the jingle of the letters *P L A N*, but because we can, by a little reasoning, find all the factors which bear on the subject and what relation they bear to it.

Let us take the case of an engine, of which we want to find the horse-power. Suppose the engine has a cylinder 16 by 30 inches, is running 75 revolutions per minute, and that a careful measurement of the indicator card, either by planimeter or calculation, shows the mean effective pressure to be 40 pounds.

The 40 pounds pressure acts on every square inch of surface of the piston, and we find this by multiplying 16 (the diameter) by itself and by .7854, because this gives the area of any circle.

Then

```
  16
  16
  --
  96
 16
 ---
 256 = square of diameter.
.7854
-----
1024
1280
2048
1792
-------
201.0624 square inches, area of piston.
```

Call this 201.06, and 40 times this gives the force urging the piston forward.

```
201.06
  40
-------
8042.40 pounds.
```

The next factor is the distance through which this force acts. The stroke is 30 inches, and as there are two strokes per revolution to a double-acting engine, the piston travels twice this, or 60 inches (or 5 feet), every revolution. Then 75 revolutions carry the piston $75 \times 5 = 375$ feet per minute, the distance through which the force of 8,042.4 pounds acts. Multiplying these we have

```
 8042.4
   37 5
 -------
 40212 0
562968
241272
---------
3015900.0 foot pounds per minute.
```

This divided by 33,000, the number of foot-pounds (per minute) in 1 horse-power gives the horse-power of this engine.

```
33000 | 3015900 | 91.39
      297000
      ------
       45900
       33000
       -----
       129000
        99000
        -----
        300000
        297000
        ------
```

or 91.39 horse-power for the engine.

If this has been carefully followed there should be no difficulty in finding the horse-power of any engine when diameter and stroke of cylinder, the number of revolutions (remembering that there are two strokes to every revolution) per minute and the mean effective pressure; i. e., the mean or average pressure which is effective in forcing the piston forward are given.

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

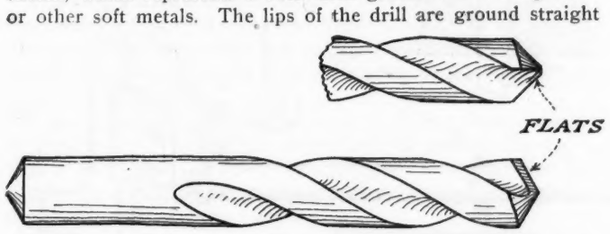
ANNOUNCEMENT.

Contributions in this column are paid for at the rate of from 25 cents to $1 each, according to their value. In placing a valuation upon any kink or idea which is sent to us, we judge solely by what we consider to be its value to our readers, and not by its length. A short letter describing some device or idea is as likely to bring a dollar as a long one.

The contributions in the January issue were the last submitted for the prize offered, and hereafter no more prizes will be given. The first prize for the January number is awarded to T. B. C., Brooklyn, N. Y., and the second prize to B. L., Douglas, Alaska.

GRINDING A DRILL FOR CUTTING BRASS.

I am very much interested in the column "What Mechanics Think," and send you a shop kink, shown in the accompanying sketch, which represents a twist drill ground for cutting brass or other soft metals. The lips of the drill are ground straight



from 1-32 of an inch to 1-16 of an inch on a line parallel to the body of the drill. This prevents the drill from catching and drawing itself forward when breaking through the work.

Torrington, Conn. W. W. COLES.

TURNING GOVERNOR BALLS.

Nearly every machinist of any experience has either had this job to do or has been asked the question, "Did you ever turn a true ball?" In a small jobbing shop where I once worked we had a governor ball to turn, say 8 inches in diameter, to match one already on the governor. No time to make gauges, no compound rest in the establishment and "the old man," a mechanical crank, said it must be round.

This is the way it was turned:

It was centered, put in the lathe and a straight cut taken parallel with the line of centers, reducing it to the required diameter, as shown in the sketch in Fig. 1. The ends were faced just enough so that the ball would stand upon a surface plate. Before taking out of the lathe a line was drawn on two opposite sides by setting a surface gauge to the lathe center. One of

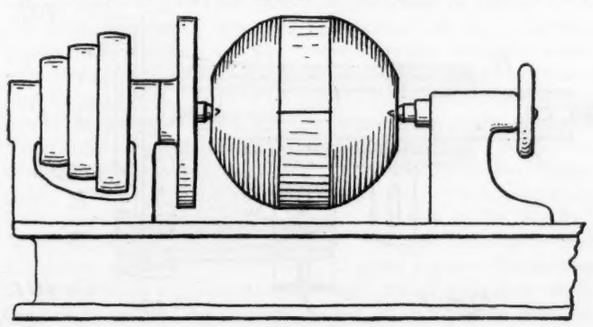


FIG. 1.

these lines appears in the sketch. The ball was then set on end on a surface plate, and a center line scribed intersecting the lines made when the ball was in the lathe. New centers were then drilled and countersunk at the points where the lines intersected and the ball put back in the lathe, being supported by the new centers just made. The ball was then turned up, using the part first turned as a guide, and by turning down so as to leave just a narrow ring on the flat—not leaving too much or cutting below the line, as the flat part becomes when you get pretty close to the size. The result was a true sphere, nearer correct than some very expensive jigs and attachments would turn out.

This principle could also be applied to spherical boring, pro-

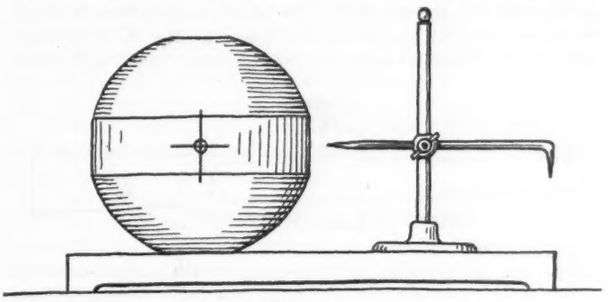


FIG. 2.

vided you could cut a groove in the work, then turning this groove at right angles to the face plate work down to it.

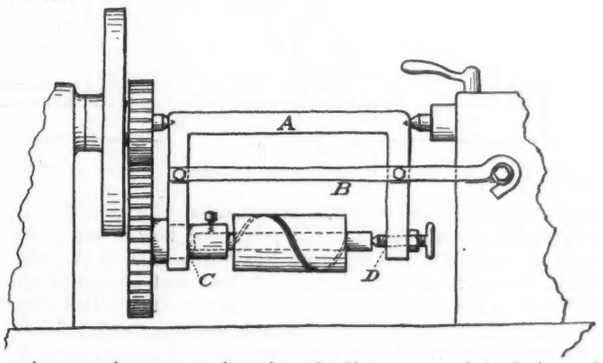
Bridgeton, N. J. E. H. Y.

FIXTURE FOR CUTTING SPIRALS.

Here is the way I got around a job for a machine which required two sleeves having spiral grooves on the outside making one turn in 2 inches. The sleeves were two inches long, ¾ inch in diameter, with a hole ⅜ inch in diameter through the center. I had only one lathe, and the coarsest thread it would cut was one to the inch.

The way the job was done is illustrated in the accompanying sketch. I took a piece of 1¼-inch square stock and made it like *A* in the sketch. This piece was supported on centers as shown, and was kept from turning around by the bent piece *B*, which was held by the clamping-down bolt on the tail-stock.

Piece *A* was fitted with a spindle at *C* having a socket, with set-screw, for a ⅜-inch arbor. At *D* was a center-pointed screw with check nut, this serving the purpose of a tail spindle for the fixture.



A 20-tooth gear was keyed to the live center of the lathe and a 40-tooth gear to spindle *C* of the fixture, which gave the required two to one reduction with the lathe geared up to cut one thread per inch. The sleeve was put on a ⅜-inch arbor, which was held in the socket *C* and by the center *D*, and the spiral turned.

B. F. GROUT.

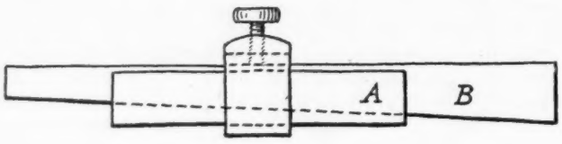
East St. Johnsbury, Vt.

After receiving the above from Mr. Grout, we wrote him asking him if it would not have been cheaper and better to have ordered an extra change gear for his lathe. In his reply he kindly furnished the following interesting particulars:

"The person who had the spirals made travelled with a circus which stayed but one day in a town, and as I am some hundreds of miles from the builders of the lathe, there would not have been time to have obtained an extra gear. I have looked up the time on the job and find that the whole job, including the making of the fixture, took just seven hours. At 30 cents an hour this would make the job cost $2.10, which would probably be cheaper than a new gear. The way I managed to fit up the fixture so handily was because I keep all odd screws and bolts, and several of these came into play. The auxiliary spindle and socket was made for another machine, and was never called for, so I had that on hand. At the time I took the job I did not know whether the lathe would do it or not, but I never let a piece of work go by my door because I can't do it."

A WIDTH GAUGE.

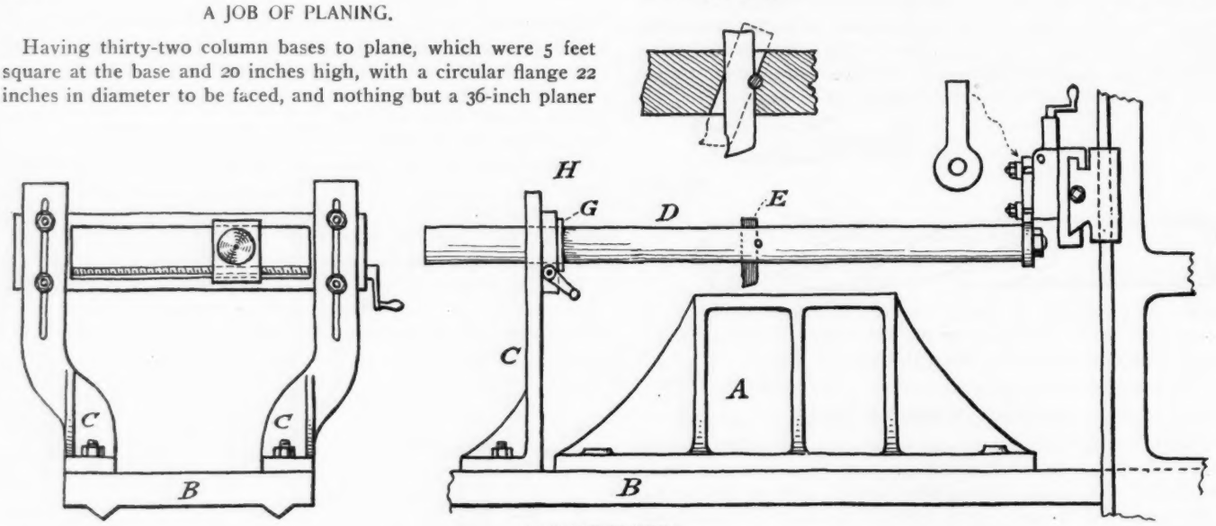
It is not easy to measure the width of narrow slots, say one-half inch wide or less, with any of the ordinary tools. Inside calipers are not convenient, and what is generally desired is to get the width in thousandths. The accompanying sketch shows in principle a width gauge that was made by Mr. A. H. Firmin, of the D. E. Whiton shops, at New London, Conn., and which



can be inserted in a slot, set to the exact width and then, after it is withdrawn, the width to which the gauge is set can be measured with the micrometers, which will give the width of the slot accurately. The gauge is essentially a small taper parallel, consisting of a piece tapered on the bottom, which slides in a taper shoe, the two being clamped in any position by the thumb-screw shown.

A JOB OF PLANING.

Having thirty-two column bases to plane, which were 5 feet square at the base and 20 inches high, with a circular flange 22 inches in diameter to be faced, and nothing but a 36-inch planer



A JOB OF PLANING.

on which to do the work, I was in somewhat of a quandary to know how to go about it. The sketch shows how it was eventually accomplished, and the work was finally done at the rate of four bases per day, taking two cuts each and employing an apprentice at 90 cents per day to run the planer. It was therefore not a very expensive job, and the work was done well.

Referring to the sketch, *A* represents the piece to be planed, *B* the planer table, and *C C* the angle plates carrying the small cross-rail, with a bushing to support the end of the bar *D*, which latter is 3 inches in diameter.

The tool is carried in a slot in the bar, and works on a taper pin, as shown in the detail sketch of the bar. The slot is relieved front and back, allowing the tool to raise on the return stroke.

E represents the tool, *G* the bushing for supporting the end of the bar, and *H* the handle or wheel for turning the screw to back up the bushing as the bar is feeding across. This feed was attended to by the boy.

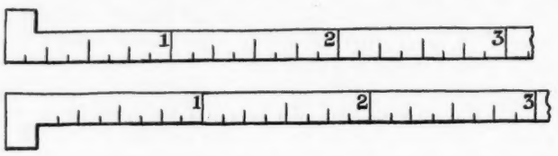
Washington, D. C. JAS. T. FINK.

WORKING COPPER.

The machinist who has only an occasional job of working copper with cutting tools is very apt to express his thoughts in language much harder than the metal, and I remember well my own first experience with it. Yesterday I dropped into Linton & Southwick's shop, Worcester, Mass., and seeing the amount of copper they were obliged to work in manufacturing their line of station switches, prompted me to ask Mr. Southwick how he managed to machine it. His answer was an amusing story of how a first-class mechanic who was having so much trouble in cutting copper pipe, etc., that he was glad to fall back on a farmer's advice and "use sweet milk and don't let the tool get dry." He was skeptical, and so am I just a little, but I am going to try it the first chance I get, reasoning as he did, that I can drink the milk if it don't work. Mr. Southwick says soda water or soap and water are good, but assures me that milk is best, and will not rust the machine. MILO.

A BLACKSMITH'S SCALE.

The following sketch is of a handy scale for blacksmiths. On one side it is marked from the end of the scale, and the other is marked from the inside of the L. A piece of hot iron can be



easily measured without the bother of having to get the end of the scale flush with the iron.

Burlington, Iowa. E. G. H.

A SHOP PROBLEM—SQUARE CENTER, ETC.

The boring bar to an old quartering lathe has a feed attachment which is of interest to machinists. The feed is fixed and depends on the two differential gears *C* and *D* driven by the two small gears *F* and *G*, Fig. 1. A sectional view of the device is shown in which *A* is the bar splined in the sleeve *B*. The gear *C* has 72 teeth, and is keyed fast to the sleeve *B*. The gear *D* has

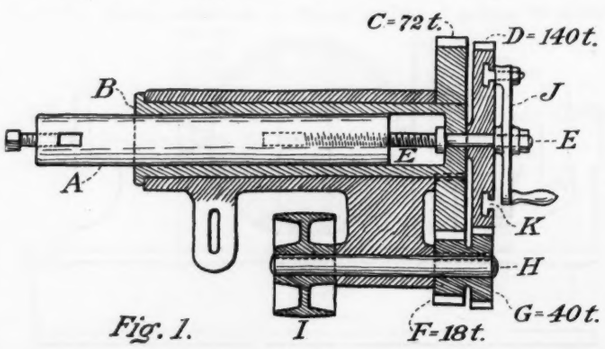


Fig. 1.

140 teeth, and is mounted freely on the blank part of the screw *E*. *F* and *G* have 18 teeth and 40 teeth, respectively, and are both keyed on the shaft *H*, which is turned by the pulley *I*. The hand wheel *J* is fastened to the screw *E*, and has a bolt with a T-head working in the annular slot *K*. When the bolt is loose, the bar is free to be moved by the hand wheel, but when it is tightened up the feed is on.

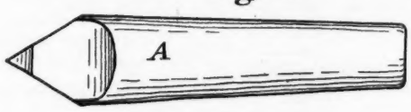
Now, with a screw of six threads to the inch, what feed is obtained to each revolution of the bar? Also, with the top of

the pulley *I* moving towards you, as shown in the sketch, what will the screw be to move the bar to the left, right or left hand?

The center reamer shown in Figs. 2, 3 and 4, although not square, is of the same breed, but it has some advantages over the common form.

As will be seen, the thickness is made about one-third of the width, and the cutting edges are practically two instead of four.

Fig. 2



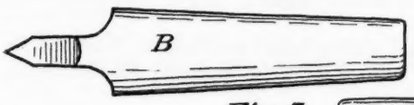


Fig. 3

Fig. 4.

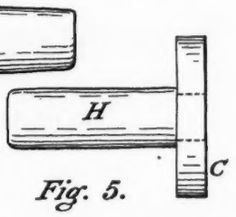


Fig. 5.

This shape saves a great amount of grinding and also presents the cutting edges in the work to better advantage (see Fig. 4). Some of the defects mentioned by Mr. Colvin are thus obviated by this form, but of course it is far inferior to the modern conveniences in this line.

A machinist having a hardened collar to reduce a small amount in thickness, mounted it on the end of the wooden handle *H*, Fig. 5, and ground it down on a common emery wheel. The result was surprising in accuracy. Work ground in this manner is generally slightly concaved.

Corning, N. Y. FRED. E. ROGERS.

NO ADMITTANCE VS. VISITORS WELCOME

What is the use, Mr. Editor, of spending large sums to advertise what a company is doing and then shutting out those who come to see for themselves? At least, this is the remark made to me by the superintendent of the Straight Line Engine Company, recently, in reply to an inquiry which I made regarding the fact that the sign, "Visitors Always Welcome," is given a prominent place over their door-way, as all your readers undoubtedly know. The Straight Line Engine Company do not advertise, but in spite of the prevailing hard times and the openness with which they conduct their business, they seem to be doing well, and are having all the work they can handle; and the only unkind reference that I have ever heard made of this company and its well-known president, came from a few of those who run their shops on the plan of exclusion, which seems to me to be rather a pig-headed plan.

My memorandum book shows that at one time or another I have had occasion to visit more than 700 shops of various kinds and conditions, and I have had many attentions and courtesies shown me at a goodly number, where otherwise attractive works were disfigured by the "No Admittance" signs, placed as prominent targets for the visitor's eye, and in many cases composed of cast iron, as if to better express the resolutions of the manager. Nevertheless, it does not give one a good feeling to run across hundreds of such signs as "Keep Out," "Positively No Admittance," "Don't Ask to See Our Workmen," "Transact Your Business at the Office," "No Visitors Allowed in the Works," "Employees Will Not Be Called Out," etc., and I do not believe it does the works any good either. It gives a prison-like feeling to the workmen and visitors alike, and I do not believe as much work is turned out, or as good feeling exists between manager and employees, as where there is more openness and freedom, which is at least apparent.

In my wanderings, I can recall but one other manufacturing establishment where a person is greeted by a sign of the character of that seen at the Straight Line Engine Company's.

This other sign of welcome was at the Vance Boiler Works, Geneva, N. Y., where "Visitors Welcome," hangs over the door, in plain sight of the traveler as he passes or waits at the station for his train.

But a unique affair in the way of a sign that one would hardly fail to notice, was seen over the door of an establishment in Norwood, Mass., and consisted of the representation of a large order book with its blank pages laid open, and above it the words, "Welcome Industry." It was probably a relic of the hard times and the presidential campaign decorations; but the fact is I have already forgotten the company's name and their line of business, both, and I am persuaded that those who visit a shop and go away so much impressed with their treatment and what they saw that they will tell all about it, whenever similar works are mentioned, are the best and most durable advertisements for the money that can be secured.

Is it not true that the value of trade secrets is largely mythical? How long would trade secrets remain such, unless entrusted to a few reliable workmen, or none at all, when former employees are so frequently secured by competitors; and if they are safely guarded against this danger, need visitors be feared?

MILO.

SAMPLES VS. DRAWINGS.

There are several ways of letting men know how you want work done. You can give them a fine drawing or blueprint, that half of them don't understand; you can swear a two-yard string of pet names at them if they don't do it right; or you can give them samples of the work, if it isn't too large.

On small work I often think samples are the best, and we have used them in our shop for years. There isn't a man so thick-headed that he can't make a piece like your sample, if he is any kind of a machinist, but he may get all befuddled on a blueprint and spoil both the work and your temper.

Even if you use gauges and jigs, the sample is of great assistance, as it shows him just how and where each hole is to be drilled and anything else he wants to know.

Of course on large work, such as steam engines or boring mills, samples are out of the question, save for some of the small pieces; but for small work, where possible, I believe it a better plan than drawings for this work. Of course, they ought to know how to read drawings, and anything that tends to help them in this way is to be commended; but it isn't economy to have them studying drawings in working hours, when a sample of the work seems to talk to them in plain English.

Take the case of valve or injector work: Drawings show the tapers of the tubes, the size of holes and taps; but who is to know just what is what, unless all the tools are plainly marked and you have a pretty complete tool-room system. Of course they ought to be marked and there ought to be no trouble; but in a small shop like ours, where your humble servant is the chief cook and bottle-washer of the tool department, it is handy to have things so a man can pick out his own tools by using the sample, as well as having it show him just how each part is to be made.

I haven't forgotten how to draw nor to read drawings, but for everyday work in the shop, in most cases, I prefer the samples every time. I don't expect others to agree with me, but "them's my sentiments."

Tombstone, Arizona. FRANK C. HUDSON.

SHOP PARALLELS.

Mr. Editor: A short time ago I had a criticism to make about the conspicuous absence of good levels among most machine-shop outfits. But levels are only the first of a long list of tools that might be mentioned as coming in the same category. How many shops are there, for example—and first-class ones, too—that have a good supply of parallels of various thicknesses, widths and lengths, and in good condition? Parallels may not come exactly under the head of "tools," but whatever family they may belong to, they can fill about as useful or as useless a place, according to their condition, as anything in the shop.

At the X——— works we had a job lot of parallels (so-called), and if there were any parts of any two surfaces that were parallel among the whole of them, no amount of measuring with a micrometer could find it out. They were kept in the tool room, but that didn't help matters any. When a man gets hold of a parallel that is battered he doesn't hesitate to give it a clip with the hammer, if it is more convenient to do so—and it generally is—nor to use it to block up rough castings. So every time the

parallels came back they were a little worse than before, until they got so bad that they were past harming.

We have a new set of parallels now, although they came like pulling teeth. After six or eight jobs had been spoiled and no end of time lost in trying to do good face-plate work blocked up on chunks of iron of all shapes and thicknesses, we finally got permission to plane up a new set of parallels, including some taper wedges that were what they ought to be. Took a man three weeks to do it, but it paid.

These parallels are now let out on check only, and are looked over when returned just as carefully as any of the tools.

The old lot was sent over to the planer department to be used for rough work, and I believe that this small addition to the shop's appliances has been of more value to the shop than any thousand-dollar machine ever put in. FOREMAN.

NAMES ON MACHINE FRAMES.

The suggestion by Mr. Olin Snow on page 128 of the December issue of "Machinery," that manufacturers of machine tools, etc., should use a name plate of cast iron of a size suitable for the machine on which it is to go, and apply it by two flat head machine screws, in a depression in the frame, could not be better calculated to play into the hands of German imitators of American machines. These worthies are in the habit of removing all name-plates that can be thus taken off, and replacing them with others, bearing their own name and address; and when they can't do that, they chip off projecting letters and scrape and paint away all traces of their little game—at least as far as they can. I suggest that American machine-tool builders, in especial, make the task of effacing their firm name as difficult as possible. It would be better for an occasional M to lack a left hind leg than that the whole name be removed. If I were building such machinery for export I would have my full name and address cast all along on the inside of the frame, repeated, as the name appears on iron rails and beams, in raised letters; and I would put my name and address on pulley faces, etc., with a knurling tool, and stamp it on other parts where it would show, but where removal by chipping or scraping would deface a bearing surface or otherwise be impracticable. A nicely stamped name and address on lathe and planer ways would do the tool no harm, and would stop this name-effacing business, not merely of machine pirates, but of accredited European dealers.

Dresden. ROBERT GRIMSHAW.

SUGGESTIONS FOR USING THE SLIDE RULE.

In regard to article in the December issue on the slide rule: The decimal point may be found by noting the position and the way the slide moves.

Thus in multiplication:

The number of digits in the answer is equal to the total number of digits in the factors, less one for every time the slide moves to the right and projects.

Every cipher after the decimal point equals a minus (-1) one digit; thus, $.02 = -1$ digit, $.002 = -2$.

Ex. (1) $36 \times 25 = 900$.

Number of digits $= 4$, and the slide moved to the right and projected.

Therefore subtract 1.

Therefore number of digits in answer $= 4 - 1 = 3$, as above.

Ex. (2) $0.025 \times 8 = 0.02$.

Number of digits $= -1$, and the slide did not move and project to the right, therefore did not affect it, therefore number of digits in answer $= -1$, as above.

In division:

The number of digits in the answer is found by subtracting the total number of digits in the divisor from those in the dividend and adding one for every time the slide moves and projects to the right.

Ex. (1) $513 \div 19 = 27$.

Difference $= +1$, and the slide moved and projected to the right.

Therefore add one.

Therefore the number of digits in the answer $= 1 + 1 = 2$, as above.

Ex. (2) $0.0175 \div 0.7 = 0.025$.

Difference $= -1$, and slide did not affect it; therefore number of digits in answer $= -1$, as above.

Combined multiplication and division:

Subtract the number of digits in denominator from those in numerator, and add or subtract the difference, according as you are multiplying or dividing, according to the above rules concerning the slide in multiplication or division.

Ex. (1) $$\frac{36 \times 90 \times 26}{75 \times 8 \times 65} = 2.16$$

Number of digits in answer $= 6 - 5 = 1$. The slide did not move and project to the right, therefore did not affect it.

Ex. (2) $$\frac{75 \times 8 \times 65}{36 \times 90 \times 26} = .464$$

Number of digits in answer $= 5 - 6 = 1$, and the slide gives $+1$; therefore number of digits $= +1 - 1 = 0$; answer is as above.

The above rules will be found very easy to remember.

Montreal. ALBERT EDWARD SMAILL.

FROM AN ENGLISH SOURCE.

WE TAKE THE LEAD IN SMALL TOOLS.

The following significant statement of the relative condition of small tool construction for bicycle manufacture in this country and in England comes from the English "Trade Journals' Review." It is a sample of the frank confessions that the English technical press are indulging in:

"It is at least twenty years since the manufacture of cycles became an important industry in this country; and although it has since grown enormously, and employs many thousands of workers, it is more than surprising that the machine tools in use in that industry are nearly all of foreign manufacture. Has the glory of Manchester, Birmingham and Leeds departed, that we must go to the United States for our small machine tools? We cannot believe that American mechanics are more skillful or more ingenious than British. The reasons for such an anomalous state of things must be sought elsewhere. Some say that the British tool makers have been so busy for many years with another and more profitable class of work that they have not found it expedient to turn their attention to the lighter tools required in cycle manufacture. There may be something in that as applicable to the present time, but it cannot be altogether true of some five or six years ago, when the tool trade was not at all oppressed with orders. The making of these special tools must have been a steady and lucrative trade for many years; and if the Americans have not greater technical skill than ourselves, they seem to possess in a higher degree the business instinct that teaches them how to turn a new demand into profitable account. There was at one time a prejudice here against American tools, but in spite of that the exports of those from the United States have been increasing amazingly of late—to an extent, indeed, that seems to threaten seriously the English tool trade. Transatlantic predominance in this department was conspicuously apparent at the Stanley Show, for there the English makers were scarcely in evidence. American tool-making firms monopolized nearly all the space allotted to machinery, and it must be owned that they were able to make a most creditable show. Uncle Sam is less trammelled by preconceived notions or conservative prejudices than we are. His automatic tools display great ingenuity in the scheming of movements and accessories to save time and to conduce to perfect workmanship. We have long been familiar in our workshops with American twist drills, gauges, micrometer callipers, and other devices, and now several firms are making specialties of capstan lathes, screw machines, and many others indispensable in the cycle industry. Specialization is carried out more thoroughly in the States than here, and in this lies the secret of American success. Most of the tool-making firms confine themselves to one or two types of tools only. One makes a specialty of brass finishers' tools, another of turret lathes, another of screw machinery, while some devote themselves exclusively to gauges and measuring instruments. In this way the utmost economy as well as perfection in the manufacture is attained. We cannot but think that British tool makers, who are not lacking in ingenuity or wealth of resource, might take a leaf out of the American book with advantage, and show, ere it be too late, that they can maintain their reputation and prestige in face of all the world."

THE "VICTORIA" GEAR CUTTER.

A new gear cutter has recently been brought out by Gould & Eberhardt, which is known as the "Victoria." It is a small size of their "New Type" machines, and in outward appearance resembles them; but its principles of construction embody a number of improved features. It is noiseless and performs its work with accuracy and rapidity, and at the same time is simple and easily managed. The machine will cut gears up to 28 inches diameter and 9 inches face, and will easily cut as coarse as 4 diametral pitch. The cutter arbor is 1¼ inches diameter. The outside support will swing the entire capacity of machine. A large feed range and the many possibilities of the dividing mechanism allow for the cutting of any size or pitch of gear within the 28 x 9-inch limit at speeds governed only by the endurance of the cutter used.

Only one belt and one pulley is used in driving the entire machine, splined shafts providing for the movements of the various slides. All are driven and drive their respective movements by spiral gearing and furnish positive separate movements. This feature does away with the numerous imperfect and tricky belts which so often give trouble.

Every movement is complete in itself, and unless all previous movements are fully and correctly completed, the next one cannot take place. The divisions of the worm wheel must be fully completed before the cutter carriage can commence its work; the cutter must have traversed its entire length before it can return, and must be back in position ready for the next cut before the next division can be made. A very essential feature provides that unless the divisions have been made complete, the cutter carriage cannot possibly feed forward. This action takes place automatically and requires no adjustment whatever for different sizes of gears. This feature prevents the spoiling of gear blanks.

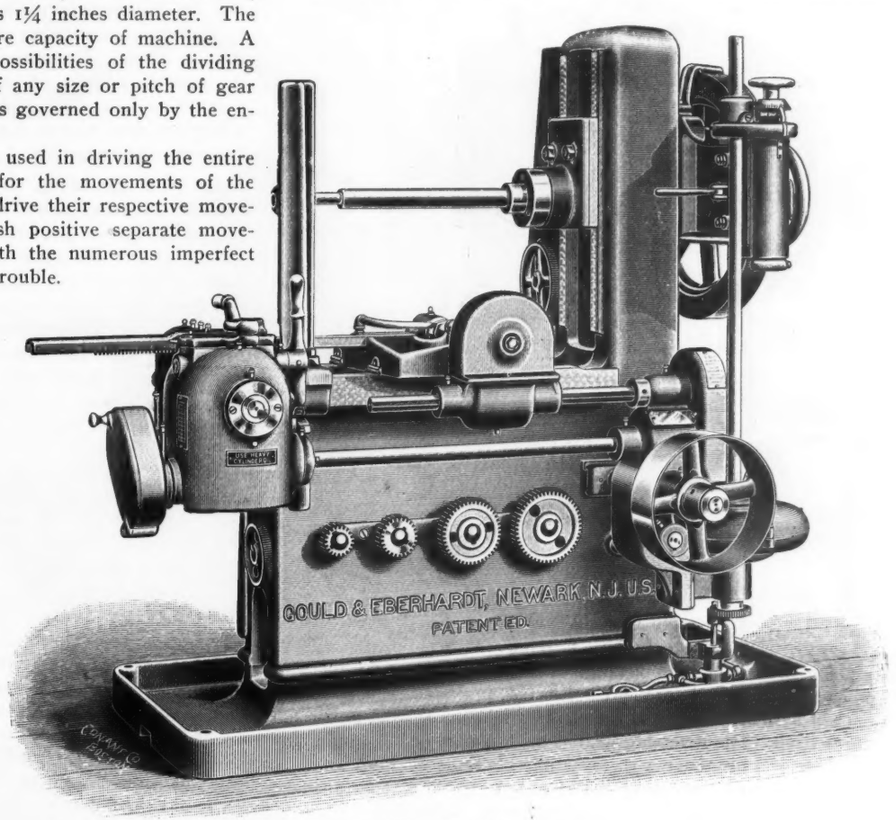
The dividing mechanism is positive in its action. The worm wheel is made in two sections, and extreme care is taken to produce an accurate wheel. A lever is provided for disengaging the worm and worm wheel, allowing the gear to be freely rotated by hand for inspection or any other purpose. The indexing train is not thrown out of mesh by this movement, so that the gear may be turned back to its correct position. A micrometer adjustment provides for slight movements of the wheel either way, for dressing teeth on one side or correcting the relative position of the cutter, as desired. The worm and worm wheel are entirely encased, which keeps out all dust; but a tight-fitting slide on the encasement can be opened to allow inspection of the movement when the worm and worm wheel are brought together. This machine will divide and cut all numbers of teeth from 4 to 100 and all from 100 to 450, except the prime numbers and their multiples.

Instead of employing a screw for driving the cutter slide, a spiral rack is used, which allows for the return of the cutter at an increased and a very rapid speed. The rack is so placed as to give a direct central thrust or pull on the cutter slide, and the spiral driving gears run in a bath of oil, which ensures an even drive and prevents chattering and excessive wear. The changes in cutter speed feed or number of teeth cut, are made by gears which slip on or off without the use of nut, screw or wrench. Each set of gears is of a different pitch and hung near the place where it is used. Numerous speeds of the cutter can be obtained by changing two gears according to the index fastened to the rear guard. This is performed in a few seconds without changing of belts on cones. All gears are neatly encased and are lubricated by means of oil tubes, which are fed from without. The cutter can be returned by hand, if desired.

A support which rests central on the sliding surface holds long mandrels firm and rigid, and it is not necessary to disturb the adjustment in the changing of work. The support swings the entire capacity of the machine.

All gears, with the exception of the pair connecting with the worm direct, are on fixed centers. This is very convenient to the workman and saves considerable time, as no adjustments for distance are required when changing gears.

Chips are deposited automatically in the base of the machine. An automatic oil pump conveys lubricant to the cutter, and a large oil pan forms the base of the machine. This feature is very essential. Besides forming a receptacle for oil for lubricating the cutter, it catches all drippings which would otherwise soak into the floor.



THE "VICTORIA" GEAR CUTTER.

After setting the work and starting the machines, no attention need be given it until the gong notifies the operator of the completion of the gear.

* * *

The testing that has been done at Purdue University upon the locomotive "Schenectady No. 1" is of a kind for which one has much respect. This work was not only undertaken upon original lines, but it has been carried along systematically and continuously under the direction of Prof. Wm. F. M. Goss. It will be remembered that the locomotive wheels were mounted upon another set of wheels, connected with powerful friction dynamometers, and that there was a device for measuring the pull at the draw-bar. Some time ago the old locomotive was removed and a new one has recently been installed, to be known as "Schenectady No. 2." The new locomotive, besides being more modern than the former one, is made to carry a boiler pressure of 250 pounds, anticipating possible higher pressures in future locomotive practice, and is supplied with a number of interchangeable cylinders and cylinder linings, making it possible to experiment with several different sizes of cylinders on the same engine and to run either simple or compound.

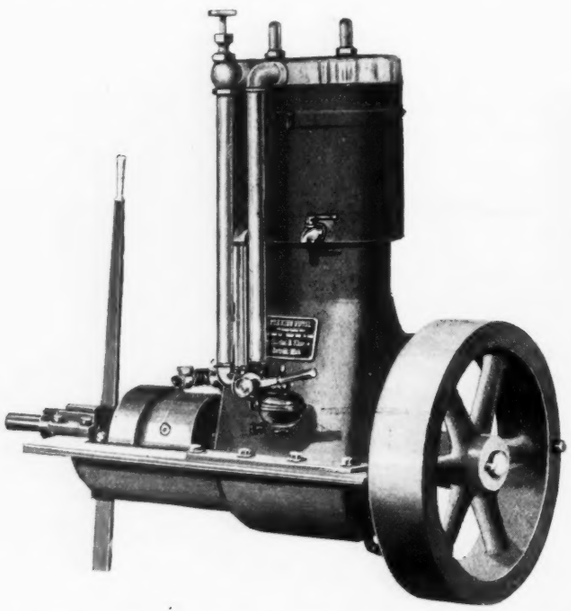
* * *

Manufacturers, either domestic or foreign, who intend building new plants or adding to their present ones, who are looking for special tools, or who want to buy or exchange machinery, are offered without charge the use of the information on these subjects accumulated in this office. Such inquiries are not published without the special request of those who send them.

GASOLINE LAUNCH ENGINE.

A gasoline launch engine recently placed on the market by the Charles B. King Company, of Detroit, Mich., is shown in the accompanying illustration. The engine is simple and compact, thus adapting it to launch service.

In starting the engine, a relief rod is pulled out, which enables the flywheel to be turned easily by hand. Two slow revolutions are sufficient to start the engine.



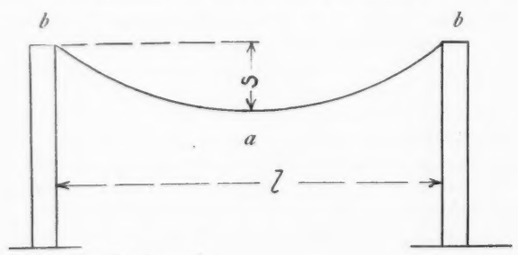
The engine operates with an impulse at every other turn in each cylinder and the exhaust is rendered silent by passing out under the water, the arrangement being such that there is absolutely no back pressure. Electric igniters are used which are of hardened steel and are claimed to wear as long as the engine itself. The reversing gear is made a part of the engine and the use of a propeller with reversible blades is avoided.

All the parts, including the cylinders, are copiously oiled by the cranks dashing the oil contained in the crank case.

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

48. L. G. asks: When a telegraph wire or a cable is suspended between two posts and hangs naturally by its own weight, how can the stress tending to break the wire be found for a given amount of sag of the wire? A. In the figure let l be the distance between the posts in feet, s the sag in feet and w the weight of the wire per foot. The curve formed by a wire hanging in this way is called a "catenary" and the greatest stress is at the points of support b, b. In order to find what the stress is at these points, however, it is necessary to first calculate it at the lowest point, a.



This is done by the formula

$$\text{Stress} = \frac{w\,l^2}{8\,s}$$

that is, to find the stress at the lowest point, square the distance in feet between the supports, multiply the weight per foot by the result and divide the product by eight times the sag in feet. Example: Distance between supports $= l = 150$ feet; weight $= w =$ ¼ pound per foot; sag $= s = 2$ feet. Then

$$\text{Stress} = \frac{\frac{1}{4} \times (150)^2}{8 \times 2} = 351.6 \text{ lbs.}$$

The operations are,
$(150)^2 = 22{,}500$; $\frac{1}{4} \times 22{,}500 = 5625$; $8 \times 2 = 16$ and $5625 \div 16 = 351.6$.
This is the stress at the lowest point, a. To find it at point b we have to make use of the very peculiar property of the catenary that the difference between the tensions at any two points is equal to the weight of a length of the wire corresponding to the difference in levels. Therefore the stress at b is equal to the stress at a plus $w\,s$ pounds, or, in the example, stress $= 351.6 + \frac{1}{4} \times 2 = 351.6 + \frac{1}{2}$ pounds. In this case, there is only a half pound difference, but with a sag of many feet this difference would amount to considerable.

49. A. C. H. writes: Having seen the Serve boiler tube advertised as saving 20 per cent, in fuel over any other style tube, can you or any of your readers give me any reason for any gain whatever over the plain or corrugated tube? A. The "Serve" tube is cylindrical and has straight ribs projecting radially inward to about one-fifth the diameter of the tube, and extending the whole length. These ribs come in contact with the gases in every part of the tube and abstract the heat more effectually than the walls of an ordinary tube; and as the water about the tube is abundantly able to carry off all the heat that the ribs can absorb, this construction amounts to increasing the heating surface per foot length of tube. The objections to these tubes are that they cannot, or at least would not, be kept as clean as the ordinary tube, and (presumably) the increased first cost. The first objection we consider to be a serious one. If the Serve people make the general claim (which we doubt) of 20 per cent. gain in efficiency, they most certainly will not be able to substantiate it. We believe that under certain conditions, where the heating surface is inadequate, a gain as great as, or even considerably greater than 20 per cent. may be effected by the use of the Serve tube—provided it is kept clean. The efficiency of properly proportioned boilers is so high, however, that it cannot be increased much, if any by adding to the heating surface. The Serve tube has given good results in marine work, especially with forced or induced draft, which calls for a large ratio of heating surface to grate area —a condition difficult to secure by ordinary means owing to the excessive weight that such a construction would necessitate.

50. G. L. A. asks: Is there a simple rule for figuring out the degrees in an angle of a right-angled triangle when only the lengths of its sides are known? It is easy to do it with a table of sines, but how can it be done without the table? A. The simplest, best and only good way is to use the table. If the table is not at hand the best way is to lay out the triangle and use a protractor. 2. Will an electric locomotive pull any more than a steam locomotive of the same weight? Some claim that the electric current increases the traction on the rails by magnetism. A. There is nothing to the magnetism theory. The idea that the electric locomotive has the greater tractive power probably came from the fact that an electric locomotive will start a heavier load than a steam locomotive of the same weight and power, other things being equal. The reason for this is not because of magnetism, but because in the electric motor there is a constant and uniform pull exerted upon the armature by the electric force, whereas the force acting upon the drivers of a steam locomotive comes from a varying steam pressure, is transmitted through the connecting rods in their different positions and is therefore quite variable. When once fairly in motion there should be no difference in the two machines.

51. J. A. G. asks: How many pounds of good wood is equal to one pound of good steam coal; also, how many cubic feet of natural gas is equal to 1 pound of the coal? A. There is very little information to be had about the heating value of wood. Professor Thurston, in his "Manual of Steam Boilers" states: "One cord of hard wood such as is used on the Northern lakes of the United States, is said to be equal in calorific power to one ton of anthracite coal of medium quality. One cord of soft wood, such as is used by steamers on Western rivers, is equal in heating power to 960 pounds or 12 bushels of Pittsburg coal." It is stated in Kent's pocketbook that "2¼ pounds of dry wood are equal to 1 pound average quality of soft coal, and that the full

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So that your high priced men are not spending their time at the grinding machine while their tools stand idle. This is one of the features of

The Gisholt Universal Grinding Machine

All kinds of machine work are now produced on such a close margin of profit that every dollar counts; and you cannot afford to have a high priced man doing work that a low priced man can do to better advantage. The Gisholt Universal Tool Grinding Machine which means the saving of a great many dollars during the year.

The essential difference between the Gisholt Grinding Machine and the grindstone or common emery wheel is that the tool is rigidly held in a suitable holder while being ground.

Will save you 20 per cent.

over the grindstone or common emery wheel. One of our customers writes:

It enables us to keep our planers constantly in motion * * * at a rough guess would say that we get *two hours per day per machine* more work than we did before we had your grinder.

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value of the same weight of different woods is very nearly the same—that is, a pound of hickory is worth no more than a pound of pine, assuming both to be dry. It is important that the wood be dry, as each 10 per cent. of water or moisture in wood will detract about 12 per cent. from its value as fuel." 30,000 cubic feet of natural gas are considered to be about equivalent to one ton of coal.

52. R. S. writes: Kindly give me an idea how to make a small induction coil. A. Make the core of soft iron wire, about 4 inches long and ⅜ diameter. The size of this wire should not exceed No. 28, and it should be soft and rusty. Wrap it together with a strong twine, not wire. Place a round head, 1¼ inches diameter, on one end, and a square head, 1½ inches, on the other end. For the primary wire use two layers of No. 20, and for the secondary fill up the spool with No. 28 or No. 30. Make the insulation as perfect as possible, and when the wire is all wound on apply as much shellac as will soak in. Get a piece of brass tubing large enough to slide freely over the coil and use this to regulate the strength of the current, which is done by sliding it over the coil so as to cover more or less of its length. Attach the coil to a base made of hard wood, about 4 x 5 inches; place four binding posts upon this base, and, to two of them, attach the ends of the fine wire secondary. Attach one end of the primary wire to one of the two remaining posts, and the other end to one of the terminals of the circuit breaker. The remaining end of the circuit breaker is to be connected with the fourth binding post. The manner of making the circuit breaker would be difficult to explain without a full set of illustrations, but as induction coils are easily found, the best way to learn how to make this part is by examining one. The parts are all in sight, so that there is no difficulty in understanding their construction. The object of the circuit breaker is to open and close the primary circuit as rapidly as possible, and it accomplishes the result by the use of a spring that is attracted to the end of the core of the coil, and then allowed to fall away, owing to the fact that when it is attracted it separates from the contact through which the primary current passes, hence, the current stops flowing and the core loses its magnetism and therefore cannot hold the spring. The battery wires are connected with the posts to which the ends of the primary wire are attached, and the handles through which the shock is taken are attached to the other two posts.

53. A. O. W. writes: I sometimes have stock to turn, afterwards to be milled to fit a wrench (hexagon or square). Knowing the size wrench they have to be fitted to, how can I calculate the diameter to turn the stock? A. For hexagon multiply the size of the wrench to be fitted by 1.1547. Thus, suppose they are to fit a 2-inch wrench. The stock should be turned 2×1.1547 =2.3094 inches. By consulting a table of decimal equivalents this will be seen to be 2 5-16 inches very nearly. For square sections multiply the size of wrench by 1.4142. Thus, for a 1½-inch wrench the stock should be turned 1.5×1.4142=2.1213 inches—; 2⅛ inches, very nearly.

54. G. J. A. writes: I have some small, delicate tools that I seldom use. I covered them with oil very thoroughly, and wrapped them in old newspapers that had been dried and warmed on the stove. In looking at them recently I found a great many small rust spots on them. What causes them to rust, and how can I prevent it? A. There are two reasons why your tools rust, either of which is sufficient. First, there is probably some acid—or at least water—in the oil, and second, there is undoubtedly acid in the ink with which the paper is printed. Procure a small bottle of pure sperm oil and some tissue paper. Warm the tools and have the paper warm and dry. Then with a small piece of dry waste, or dry cloth, spread a coat of the sperm oil over the tools and wrap them, separately, in sufficient tissue paper to quite exclude the air. In this way you can keep them without fear of rusting.

55. R. K. writes: If two 100-horse power boilers were to be placed 350 feet away from the engine and the steam carried underground to the engine, what would be the best arrangement for the purpose? A. Carrying steam underground to an engine for a long distance is not very satisfactory, especially in cold climates, unless a good deal of pains are taken in the arrangement of pipes. Cover the pipe in the best manner with some one of the numerous pipe coverings and enclose in a strong wooden box. Make all screwed joints—no flange joints—and before covering thoroughly test the pipe and make sure that there are no leaks. The pipe should be put together in the most thorough manner, and the box that encloses it should be strong and tight. Lay the pipe direct to the engine room, that is, without bends or turns, so that it may be free to expand and contract, providing for this either in the engine room or boiler room, or both, and nowhere else. Keep the pipe blocked up so that it will not touch the bottom, sides or top of the box. Lay it inclined toward the engine room, the incline being not less than 12 inches, and trap the water there before the steam passes to the engine. Thoroughly coat the box, inside and outside, with tar, cover with roofing paper, then again with tar. If you take these precautions the whole arrangement will last twenty-five years. Be sure that the pipe is as large as you are ever likely to require, and lay it well below the effects of frost. 2. What will be the loss from taking the steam that distance? A. If the pipes are protected as indicated, or in some other way equally good, probably not less than 5 per cent., nor more than 10 per cent.

56. J. K. W. writes: I wish to use an arrangement something as sketched in Fig. 1, to force apart the two blocks A and B, but I do not know how to calculate the force operating to separate

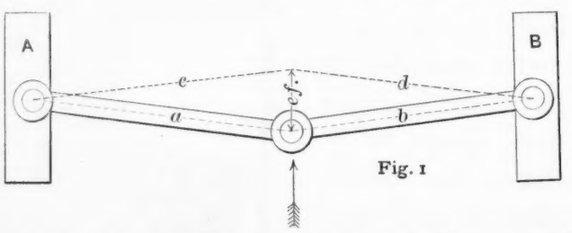


Fig. 1

the blocks. Can you tell me how I can do so? The arrow indicates the direction in which a force of 200 pounds is to be applied. A. Draw the lines *a b*, representing the direction of the two forces acting through the arms. Complete the parallelogram by drawing the lines *c d* parallel to *b a* respectively and draw the diagonal *e f*. As much greater as the combined length of the lines *a* and *b* is than the line *e f*, so much greater will the force be that operates along the two lines, half this being the force operating along each line *a* and *b*. Say the length of each line is 12 inches; their combined length is 24 inches. The length of the diagonal is ½ inch. Then the total force exerted is (24÷½) ×200=9,600 pounds, one-half along line *a* and one-half along line *b*. All this force is not operative to force the blocks apart because it is not exerted in exactly the line in which the blocks move while being separated, but these lines are so nearly coincident in the ordinary toggle joint motion, which this is, that their variation need not be considered. 2. What will I gain by

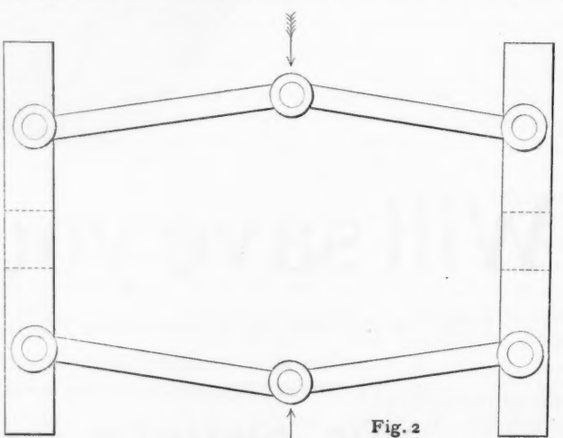


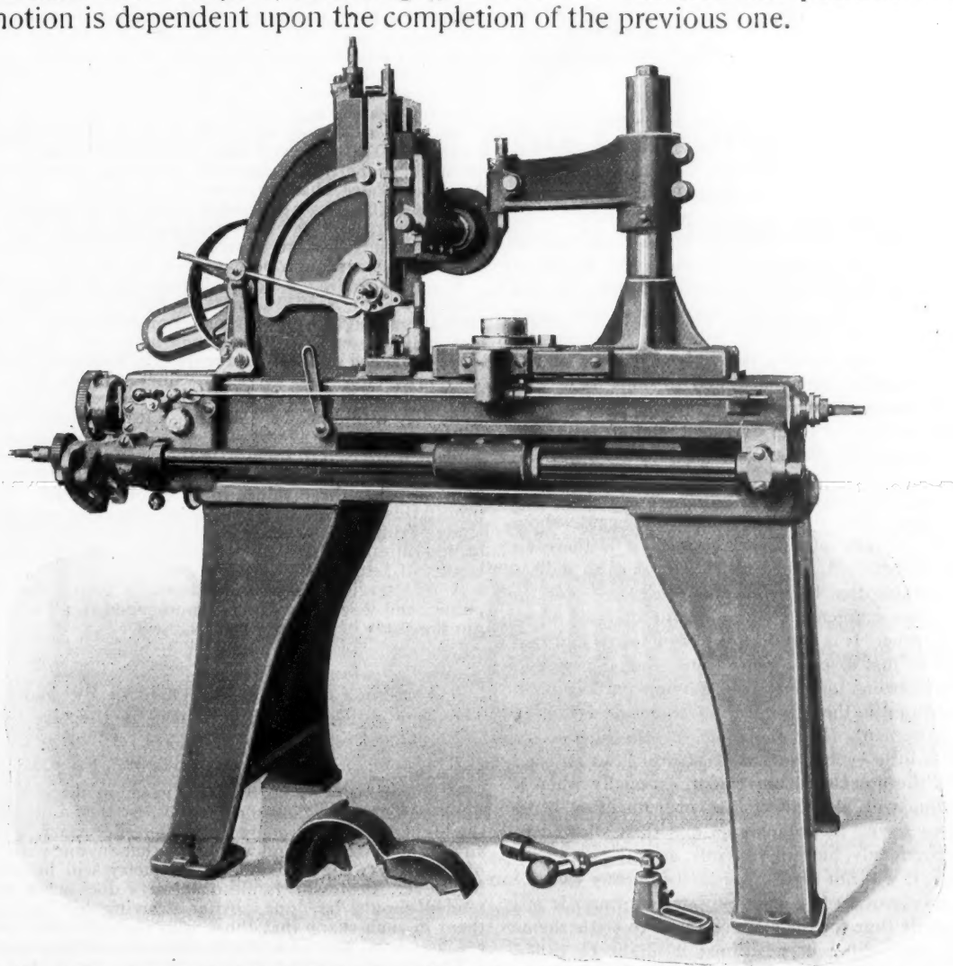
Fig. 2

using two sets of arms, as in Fig. 2, exerting 100 pounds force in the direction of each of the arrows, or as now, 200 pounds altogether, or what is the advantage of the double toggle? A. There is no "gain in power" by the use of the double toggle. Your multiplier will be 100 instead of 200 as above, and the two sets of arms will exert the same outward pressure as the single set. The advantage is that the pressure may be exerted over a

The Whiton Automatic Gear Cutter

Is a radical departure from any other machine for the same purpose. Instead of endeavoring to improve the types of Gear Cutters that were in existence several years ago, when the construction of this machine was begun, the makers laid down certain principles which it was believed should be followed in order to produce a machine of the highest efficiency as well as of mechanical excellence. These principles were adhered to, and the various parts of the mechanism were worked out in accordance with them. As a result the Whiton Gear Cutter embodies the features that its designers at the start considered to be either essential or desirable.

All superfluous belts, friction devices, chains, belt tighteners, and other unmechanical arrangements have been done away with. Only one driving belt is used; positive motions have been adopted, including gear drive for the feed and positive clutches. Each motion is dependent upon the completion of the previous one.



No. 1 Machine will cut, spur and bevel gears to 5 diametrical pitch, 34 inches diameter and 7 inches face, besides hobbing worm gears without nicking the blanks. It will divide for all numbers from 4 to 100 and all even numbers and many others to 200, besides a wide range of higher numbers.

The Whiton Automatic Gear Cutter is adapted to gear cutting, hobbing worm wheels without first nicking the blanks, and to rack cutting. It is the best all around tool on the market for gear cutting.

Full particulars furnished by the manufacturers,

THE D. E. WHITON MACHINE COMPANY,

No. 54 Howard Street, New London, Conn., U. S. A.

greater surface, as shown in Fig. 2, or two sets of blocks, as indicated by the dotted lines, may be employed.

57. R. Y. writes: I am driving one shaft from another, transmitting about 40-horse power, as near as I can come at it. The pulleys are 28 inches diameter, the same diameter on each shaft. I use a 10-inch double belt, but it constantly slips, causing much annoyance. I have no more room for a wider face pulley, but plenty of room overhead for a pulley of larger diameter. What will I accomplish by using pulleys of larger diameter? A. Unless the speed is excessive, which it cannot be in your case, the power the belt will transmit is in direct proportion to its speed. If you double the diameter of the pulleys you will double the power the belt will transmit, which will undoubtedly remedy all the trouble from slipping. You will double the power the belt will transmit, because you will double the speed of the belt by doubling the diameter of the pulleys. It is always advisable to use large pulleys. Belts and shafts will last longer, and the driving will be in every way more satisfactory. 2. If I cut away from the timber that is in the way so as to use a 12-inch belt, what will I gain? A. You may consider, with belts so narrow as these, that the driving capacity will be in direct proportion to the width. Then 10 : 12 : : 40 : 48. You could transmit 48-horse power as easily as you now transmit 40. Or, to put it another way, your driving will be 20 per cent. easier. The larger pulleys are the best remedy.

59. W. P. asks: What are the advantages of heating by overhead pipes, and what the disadvantages? It appears to me that it must cost more to heat from overhead, becauses heated air rises. A. When heating is from below the pipes are placed near the walls to keep them out of the way and the walls conduct away a good deal of heat. When they are overhead they may usually be placed in clear space some distance from the walls, which do not then absorb so much of the heat. The overhead pipes are also more out of the way than pipes near the floor, however the latter are placed. It is true that heated air will rise, owing to its greater levity, but when the heating is overhead the air at the top of the room is expanded by the heat and so finds its way to the floor, thus maintaining a circulation. At the present time many Eastern mills are heated from overhead, and so far as we know the plan is universally liked. We know of no disadvantages of overhead heating.

60. R. W. A. asks: Does the steam engine indicator show the pressure in the cylinder of a steam engine, or is there an error, and if so, how great? A. The probable error of an indicator diagram is something that has been much discussed, and an English writer of some eminence claims that the diagram lacks 10 per cent. of being true. It is certain that the indicator diagram is not quite true, and just as certain, we think, that it is not 10 per cent. in error. Owing to inertia the moving parts will, in reason, be a little behind in their upward movement as well as in their downward movement. For the same reason the upward movement will be a little—sometimes a great deal—too far, and the same is true of the downward movement, especially when it is violent. Friction will also affect the instrument a little. Furthermore, if any spring be compressed and then allowed to extend itself rather suddenly, but not violently, as is the case with an indicator spring, it will not actuate a pencil in a way to indicate the same in its downward as in its upward motion. It appears to require a little time for the atoms of steel to settle themselves together in their different positions; it might be called atomic inertia, perhaps. Whatever the case may be, it is a fact beyond dispute that a spring does behave in this way. But the sum of all these errors, assuming them to be cumulative, is slight. With a view to testing the effect of inertia, the writer placed two indicators on the cylinder of an engine, so arranging them that neither had the advantage in the way of getting steam. The piston and the parts actuated by it of one of these instruments were almost exactly twice as heavy as those of the other. The springs —a 40 for each instrument—were carefully calibrated. The arrangement was such that the diagrams were simultaneously taken by the two indicators. The speed was such that the spring was a little light for the instrument with the heavy reciprocating parts, although such a spring would be very commonly used under the same conditions. Ten diagrams were taken by each indicator, and carefully measured with the planimeter. The difference for the ten, as between the two instruments, reduced to terms of horse-power, was less than one-half of one per cent. The diagrams from the instrument with the heavy reciprocating parts were wet slightly, and it was not easy to calculate them, but they were substantially correct, going to show that the effect of inertia was very small. The indicator is not a perfect instrument, but it is perfect as instruments go.

61. E. W. A. asks: What is the voltage of the crow foot battery used in telegraph stations, and what is the amount of current in amperes or fraction of an ampere? A. The electromotive force of these batteries is about 1 volt—it varies from 1 to 1.10. The resistance is about 3 ohms, so that to work with good efficiency the current should be over three or four-hundredths of an ampere. If necessary, the current may be run up to one-quarter of an ampere.

FRESH FROM THE PRESS.

The Strength of Materials. A text-book for manual training schools by Mansfield Merriman, Professor of Civil Engineering, Lehigh University. 124 pages, 12mo. John Wiley & Sons, New York. Price, $1.

Professor Merriman occupies a unique position among technical writers in this country. While he presents his subjects in a scholarly manner, he generally puts what he has to say in such form that others less talented than he, or students who are seeking after information, can understand what he means. It may be supposed, therefore, that when he sets out to write an elementary treatise, such as this is, it will be very clear indeed.

No mathematics are used in the book beyond algebra and trigonometry. The different chapters treat of electric and ultimate strength, properties of materials, moments, cantilevers and simple beams, columns, shafting, elasticity, resilience, and a final chapter with miscellaneous applications. The treatment of beams is of course elementary and does not take up any of the more complicated loadings that are often met with. This is true, also, of the other subjects, though perhaps to a less degree.

We miss finding a table of moments of inertia of the more common beam sections, and we believe the book would have been improved by adding more complete tables of the strengths, elastic limits, etc., of the various materials. In this, as in his more advanced text-book on materials, Professor Merriman gives very brief tables of "average" values. While these values may be suited for "average" conditions, for very many other conditions they would not be. Although it is distinctly stated that the values are "rough averages" and subject to great variation, the student is advised to memorize them, and unless he is very carefully instructed, the inevitable tendency must be to grow into the habit of using these values in an empirical way. We call attention to this point so that any reader who may wish to take up the study of this book will be on his guard and realize the importance of determining what values should be used in any case from the results of actual tests on materials.

A real service has been rendered in giving this book to the public, and it is to be highly commended to all who wish to begin the study of this important subject.

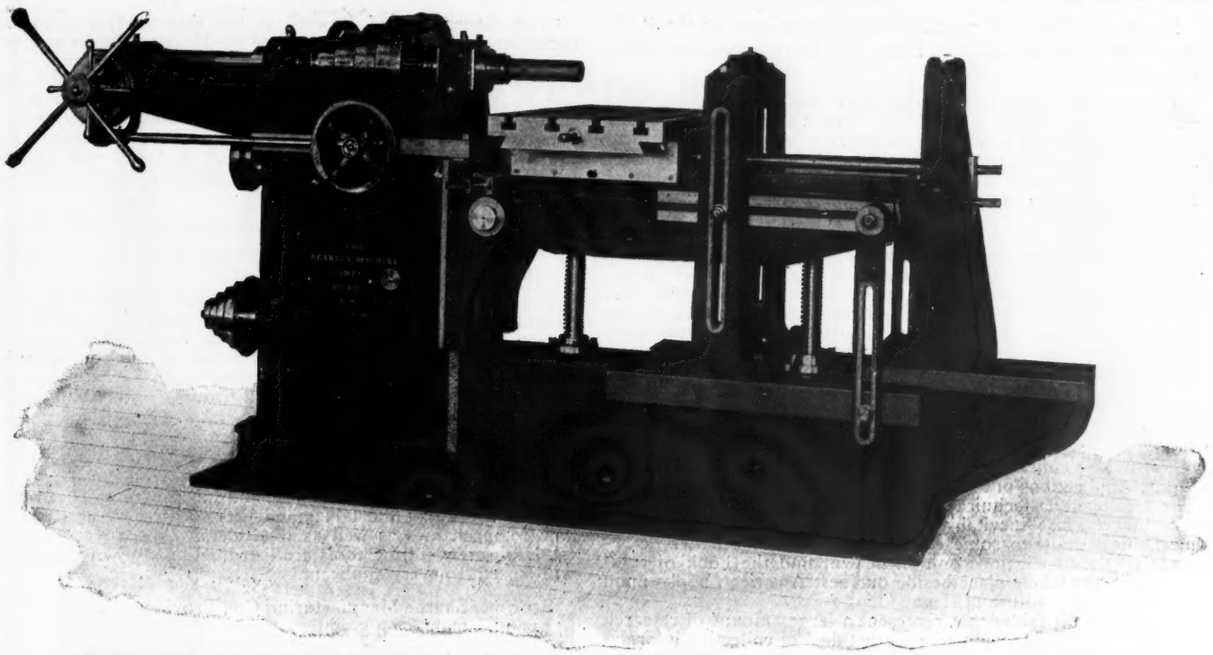
* * *

A Text-book on Applied Mechanics. By Andrew Jamieson, Professor of Electrical Engineering in the Glasgow and West of Scotland Technical College. Vol. II. 388 pages, illustrated. J. B. Lippincott Company, Philadelphia. Price, $2.50.

This work is of about the same grade as the well-known Text-book on Steam and Steam Engines, by the same author. While the higher mathematics are used where necessary, it is not strictly an advanced treatise, and we believe that anyone with a knowledge of elementary algebra and trigonometry will be able to use it. Moreover, Professor Jamieson always does what we have contended should be done. After deriving his formulas he puts them in such shape that those who cannot follow the derivation can use them, and he illustrates their use with examples.

The second volume contains chapters upon motion and energy, graphic statics, strength of materials, and hydraulics. The first topic includes the subjects generally treated under this heading, and in addition a discussion of pendulum governors. Under Graphic Statics the stresses in roof trusses, cranes, beams and simple mechanisms are taken up. The treatment of the strength of materials appears to us to be unusually complete, considering the small space occupied (85 pages), with the exception that the strength of columns is omitted entirely. Some of the more advanced subjects like moving loads, thick cylinders and the catenary are treated, though others, like continuous girders, are omitted. The chapter on hydraulics is not as complete as it is eventually intended to make it.

The volume under review should serve as a useful handbook for one engaged in practical work. It is also well adapted to students' use, as there are a great many examples given for solution. As would be expected, some features are a little different from American practice—for example, stresses are given in tons per square inch, not only for roofs and girders, but for all beams.



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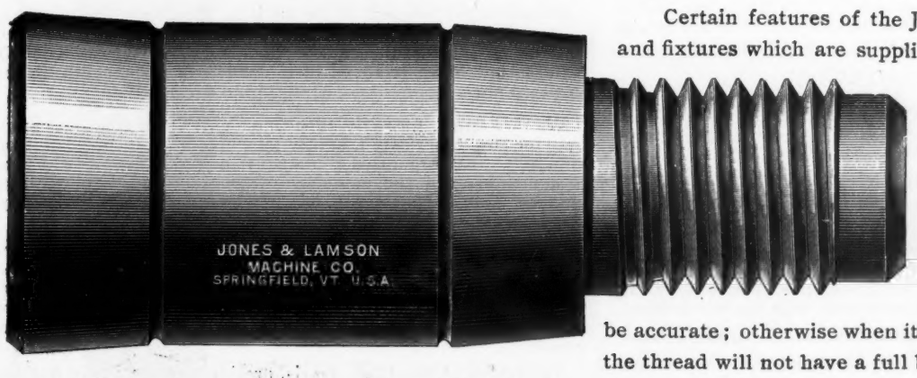

Certain features of the Jones & Lamson Turret Lathe and fixtures which are supplied with the machine, make it especially adapted for turning out bolts and pins of a variety of shapes at the smallest possible cost. In the illustration one pin has a long thread, and in order to secure satisfactory results with a thread of this length its pitch must be accurate; otherwise when it is screwed into a tapped hole the thread will not have a full bearing. The Hartness Automatic Die supplied with the flat turret lathe, is the only die which will produce a thread of the correct pitch.

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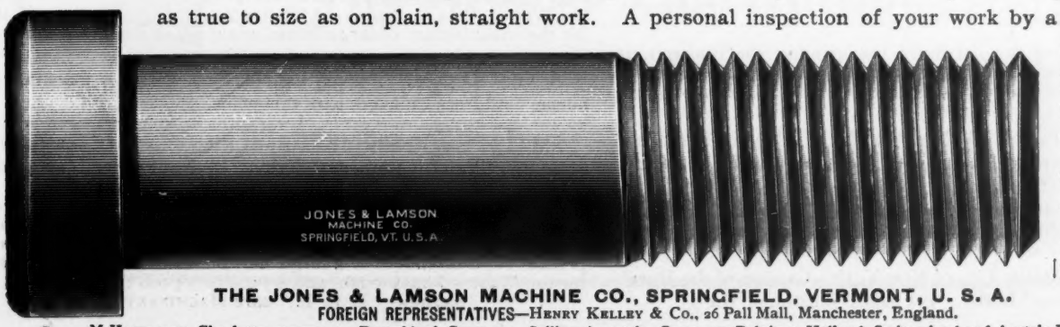

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Mechanical Draft. A practical treatise published by the B. F. Sturtevant Company, Boston, Mass. 385 large pages, illustrated. Price not stated.

This work needs no introduction to readers of this paper. It is written by Mr. Walter B. Snow, the author of the series that has been running in our columns, and before being put in book form these articles were thoroughly revised and largely added to, and present the only complete and comprehensive treatment of the subject that has yet been published.

The publication of the work shows a commendable spirit on the part of the B. F. Sturtevant Company. While it is undoubtedly expected that the issuance of the volume will bring increased business, it is an advertisement only in that more prominence is perhaps given to the applications of the system than would otherwise be the case, the apparatus used to illustrate these applications being of Sturtevant manufacture. Of course, also, the extended experience of this company has been drawn upon for data bearing upon the subject.

The book is divided into thirteen chapters, as follows: Water, including tables of its various properties; Steam; Combustion; Fuels; Efficiency of Fuels; Efficiency of Steam Boilers; Rate of Combustion; Draft; Chimney Draft; Mechanical Draft; Advantages of Mechanical Draft; the Sturtevant Fans for Mechanical Draft; Applications of the Sturtevant Fans for Mechanical Draft. The treatment is technical, but clear, and its high character in a technical sense inevitably leads the reader into believing in mechanical draft, to some extent at least. But whether he accepts all the conclusions or not, he will find the book of sufficient value to take a place beside our best American books upon the generation and use of steam.

There are 141 tables that represent a large amount of research and hard labor and which give a great deal of collective information upon the general subject of boiler economy, including the use of fuels and steam.

The Arithmetic of the Steam Engine. By E. Sherman Gould. 77 pages, 8vo. D. Van Nostrand Company, New York. Price, $1.

This small book contains forty-three examples relating to steam and the steam engine, each of which is worked out and accompanied by a statement of general principles where necessary. The author states that it is believed that these examples contain all that is necessary to solve the ordinary problems relating to steam in its application to the steam engine. The preparation of the work grew out of his need of a collection of facts and rules such as he was unable to find in any single treatise which he had.

The first chapter is upon heat, and after stating the principal useful facts regarding heat, including absolute zero, six practical examples are worked out. This method is followed throughout. For example, under compound engines a general discussion is given, with reasons for and effect of compounding, and a few useful facts about these engines, together with several examples. Tables of saturated steam and hyperbolic logarithms are added, and the book will undoubtedly be valued by any person who has become accustomed to its use.

ADVERTISING LITERATURE.

THE ANDARD SIZES FOR CATALOGS ARE 9 X 12, 6 X 9 AND 3½ X 7¹ INCHES. THE 6 X 9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

Hilles & Jones Co., Wilmington, Del. Catalog "O" of Machine Tools for Boiler Makers, Bridge Builders and Workers in Plates, Bars and Structural Shapes Generally. 44 pages, 6 x 9 std.

This is not intended for a general catalog, but presents illustrations of a few of the more recent designs of punches, shears and bending and straightening machines, of regular and special patterns. Some of the machines are shown with electric drives.

Stow Manufacturing Co., Binghamton, N. Y. Catalog No. 7 of the Stow Flexible Shaft and Portable Appliances for Drilling. 56 pages, 6 x 9, illustrated.

The Stow flexible shaft is arranged with either electric or rope drive for driving portable drills, reaming and tapping machines, portable emery grinders, etc., and the catalog explains these various uses and gives descriptions and price lists of the appliances made by this company.

Norton Emery Wheel Co., Worcester, Mass. Catalog of the Walker Universal Tool and Cutter Grinder (improved). 48 pages, 6 x 9, illustrated.

Besides showing the details of the grinder, the illustrations represent various typical operations to which this grinder is adapted, and the character of the work which it is capable of handling.

Mackey Print Paper Co., Pittsburg, Pa. Catalog of Engineers' Instruments, Drawing Instruments, Materials and Supplies. 235 pages, illustrated, 6 x 9 inches. Price, 50 cents.

A very large assortment of instruments and materials are listed in this catalog, and as the prices are also given it will be a valuable book to have on hand in the drawing room.

The Hazelton Boiler Co., of New York. Catalog of the Hazelton, or "Porcupine" Boiler. 152 pages, illustrated, 6 x 9.

"The Generation of Power" is the title of this handsome pamphlet. A detailed description of the Hazelton boiler is given, with illustrations of various plants. There is a discussion of various points concerning the economical production of steam, and information about feed-water heaters, the flow of steam, sizes of steam pipes, the rating and care of boilers, safety valves, chimneys, etc. There are also numerous tables, including the properties of saturated steam, and the A. S. M. E. code of rules for boiler testing. It is a catalog that will be appreciated by any steam user.

Tight Joint Company, 159-161 Bank street, New York. Catalog of Pipe Fittings and Flanges for heavy pressures. 85 pages, 5 x 6¾.

The first part of the catalog is devoted to a description of the "Tight Joint" fittings. The second part contains a useful collection of tables, hydraulic memoranda, information regarding hydraulic pressure transmission and information on hydraulic rivetting, forging and flanging, prepared by John Platt. The second part contains 50 pages, and will prove of interest to anyone interested in hydraulics.

The J. M. Carpenter Tap and Die Company, Pawtucket, R. I. Catalog of Screw Cutting Tools. 112 pages, pocket size.

This is an entirely new cataiog, and much care has been exercised in arranging the tables and lists so as to make it acceptable to mechanics as well as to dealers. About 5,000 sizes or kinds of screw cutting tools are listed, and a copy of the catalog will be sent to every applicant.

Brown & Sharpe Manufacturing Co., Providence, R. I. Catalog of Machine Tools and Small Tools.

This is the 1898 edition of the regular Brown & Sharpe catalog which so many machinists keep in their tool chests as a reference book. The Brown & Sharpe Manufacturing Co. are successors to Darling, Brown & Sharpe, and in this edition of the catalog the machine tools are conveniently grouped together in the first half and the small tools in the latter half. Among the new small tools of interest to machinists are an inside micrometer and a micrometer depth gauge.

MANUFACTURERS' NOTES,

The Nicholson File Company, of Providence, R. I., sent to their trade friends in January a tasteful greeting in the form of an old English parchment sheet containing appropriate well-wishes.

The National Association of Manufacturers have issued a circular of information, No. 20, containing suggestions concerning reforms in patent laws. This circular will be sent upon application by addressing No. 650 Elston avenue, Chicago, Ill.

Owing to the removal of the auditing department of Westinghouse, Church, Kerr & Co., from New York to Pittsburg, Mr. Warren L. Murray, the auditor, and Mr. Gardner W. Kimball, his associate, have removed their residences permanently to the Western city.

W. S. Rogers, formerly superintendent and mechanical engineer of the American Laundry Machinery Company, of Cincinnati, O., has organized a company in New York, of which he is a member, for the manufacture of high-grade laundry machinery. The business will be conducted at 127 West Twenty-third street.

The Joseph Dixon Crucible Company have again done the handsome thing by the editor in sending a collection of their excellent pencils as a New Year's greeting. Favors of this nature are not only pleasing, but make a lasting impression, for every time a pencil is used the Dixon Company is instinctively remembered.

The return of Mr. Chas. Davis, president of the Davis & Egan Machine Tool Company, from a recent European trip was the occasion of a reception and dinner tendered him by the Manufacturers' Club of Cincinnati. Mr. Davis made an address in which the opinions and suggestions voiced the results of his extended acquaintance and experience with the conditions of our trade abroad. In this connection it may be added that this company find it necessary to again enlarge in order to keep pace with their orders. They have secured the plant formerly occupied by the Walton Iron Company, at Covington, Ky., and will equip it for the manufacture of large lathes, planers and boring mills.

A GOOD SALESMAN wanted by a Chicago machinery house. Address Chicago, care this office.

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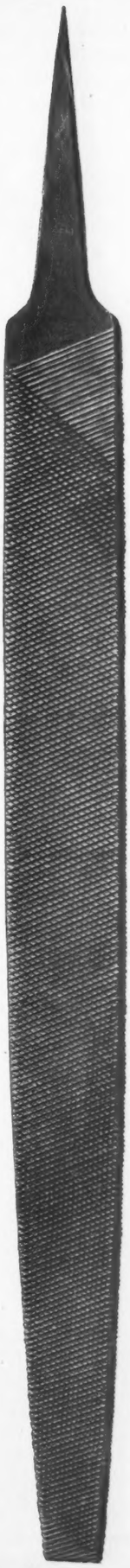

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EDITOR'S NOTES.

Young mechanics will find in this issue plenty of material for study, which will help them directly in their work in the shop. Professor Van Dervoort's article upon files gives information that even men who have had many years experience in the shop will be glad to get. In addition to this "Milo" explains some principles in milling in an interesting manner, and there is also a page devoted to formulas—that stumbling block in the pathway of every mechanic who seeks to study for himself.

We have recently received an appreciative letter from a machinist who is unable to get out among the shops but who finds the shop notes that we publish keep him well informed on the best shop practice. This month our readers will have the advantage of seeing the way work is done in a leading shop in Germany, and in the next number there will be an interesting article describing a few of the methods in use at one of the leading Western shops.

There are few pattern makers or even machinists who will not be benefited by reading carefully the articles upon pattern making written by I. McKim Chase. The class of work which he deals with is enough out of the ordinary, and is sufficiently different to bring up new points in every issue. The articles and drawings are both strictly new, and present matter of a class that as far as we know has never been published.

Will B. C. B. send his address to this office, as we have mislaid his letter.

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